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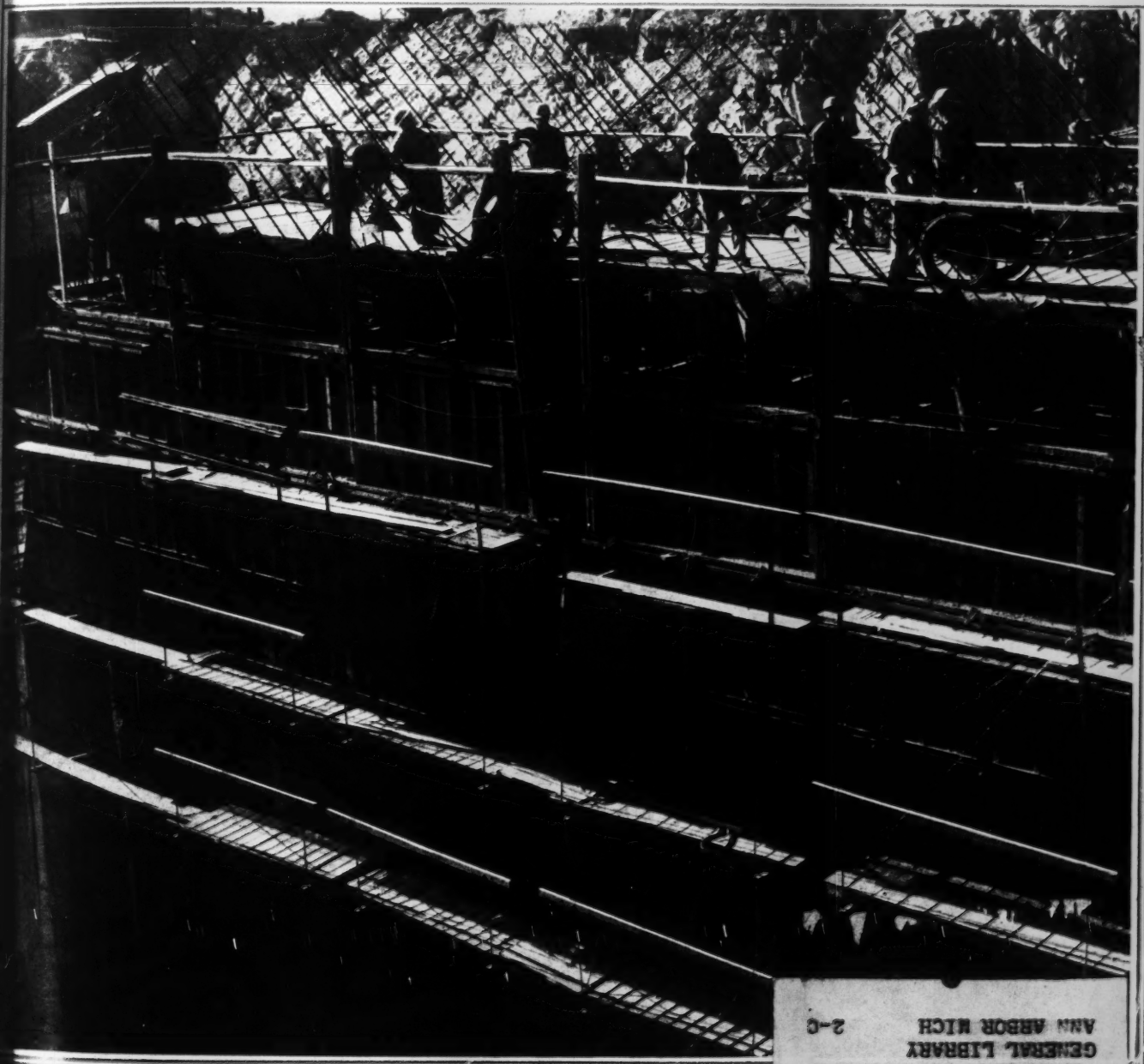
July 7, 1938

Concreting one of the buttresses at Bartlett Dam



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· ENGINEERING NEWS-RECORD
JULY 7, 1938

THE WEEK'S EVENTS

PWA Grants Halted By Hetch-Hetchy

San Francisco will get no allotments until it decides on procedure to meet court order

San Francisco, which has PWA applications pending for projects totalling some $100,000,000, will get no allotments until it shows how it intends to dispose of the power from its Hetch-Hetchy water supply system in compliance with the law, as interpreted by Sec. Ickes and upheld by a district court last April.

This has been made clear by PWA Administrator Ickes, who feels that "PWA owes it to the city to help it obey its obligations under the Raker Act." The official attitude of PWA is expressed in the following telegram to Mayor Rossi of San Francisco:

"In considering all applications for funds the PWA must determine the financial feasibility of each project and the legal and financial ability of the applicant to provide the non-federal funds necessary for the project. Such determination cannot be made without full knowledge of all projects and expenditures contemplated by any applicant or which an applicant is obligated to undertake.

"Such determinations as to San Francisco's applications are obstructed by lack of definite information as to what course the city proposes to follow in complying with the decree of the United States court in the Hetch-Hetchy litigation and in fulfilling its legal obligations under the Raker Act. May I be fully advised on that matter?"

The Hetch-Hetchy controversy dates back many years. The Raker Act, approved by Congress in 1913, permitted the city to develop a water supply on federal lands on condition that none of the water or power should be sold to any individual or corporation except municipal water or irrigation districts for resale. The city did, however, sell power to the Pacific Gas & Electric Co. for distribution to its customers. In 1925 this arrangement was revised and a "temporary" contract entered into by which the company acted as the agent of the city. This is still in force but will be enjoined next November at the expiration of the six-months grace period granted by the district court.

Meanwhile the voters of the city have repeatedly refused to approve bond issues to finance the construction of a municipal distribution system. A proposal is now pending for a referendum vote to determine whether the city should purchase the distribution facilities of the company.

MAJOR NEWS

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Housing Foundation Formed at M.I.T.

Establishment of the Albert Farwell Bemis Foundation has been announced at the Massachusetts Institute of Technology for the study of housing. It will be directed by John E. Burchard of Winchester, Mass., for several years vice-president of Bemis Industries, Inc., who will begin his duties in September.

The foundation will co-operate especially with the departments of architecture and civil engineering. It will co-ordinate available knowledge on materials, construction methods and the economics of shelter and will stimulate research in various phases of the building industry, studying also the transportation and distribution of building materials, the effect of mass production technique, behavior of building materials singly and in combination.

Wages Stabilized On Housing Jobs

Local contracts prevent wage rate changes while construction is underway on public housing

Elimination of wage disputes and jurisdictional strikes on slum-clearance projects sponsored by the U. S. Housing Authority is hoped for as the result of a new type of labor agreement already negotiated in over 50 cities and steadily being extended.

Because the federal program is decentralized, the actual agreements are between local housing authorities and local building trades councils. The idea, however, was originated in Washington and perfected in discussions between Walter Price, acting director of labor relations for U.S.H.A., and Herbert Rivers, treasurer of the construction and building trades department of the American Federation of Labor. Its application to local conditions has been facilitated by a letter sent by the A.F.L. to over 450 local building trades councils endorsing the principle. (*ENR*, May 19, 1938, p. 704.)

The new type of contract guarantees that once a housing project is started, the prevailing wage rates for building trades will not be changed until it is completed and that work will not be suspended because of jurisdictional disputes until there has been ample opportunity for adjustment through negotiations at which the local authority, the U.S.H.A., and the A.F.L. will be represented.

Labor disputes and the resulting cost increases are of great importance to U.S.H.A., which has little leeway between the rigid cost-per-unit limitations in the Wagner Act and the necessity for building for a 60-year amortization period.

Shasta Contract Let

Contract for construction of Shasta Dam on the Sacramento River in California, second largest dam in the world and largest item in the Central Valley's project, has been awarded to Pacific Constructors, Inc., a syndicate of twelve construction firms on their low bid of $35,939,000. (*ENR*, June 9, '38, p. 795.)

CONTRACTS AND CAPITAL

THIS WEEK'S FIGURES

(Thousands of dollars)

CONTRACTS

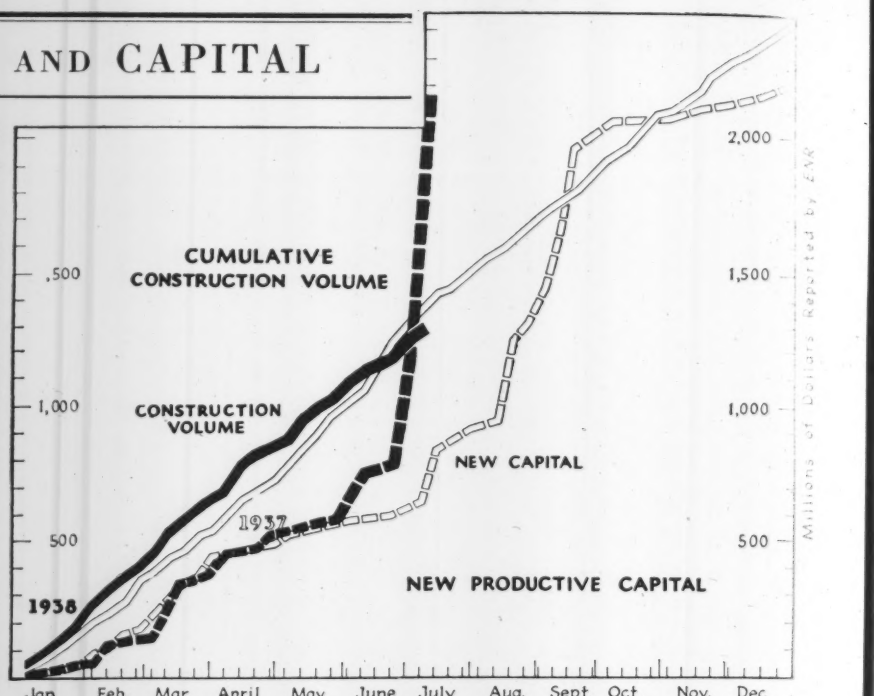
	Week Ending July 8 1937	June 30 1938	July 7 1938
Federal	$2,847	$10,061	$38,675
State & Municipal	43,781	47,526	31,547
Total public	$46,628	$57,587	$70,222
Total private	20,370	10,033	8,100
TOTALS	$66,998	$67,620	$78,322

Cumulative
1938 (27 weeks) $1,333,253
1937 (27 weeks) $1,367,904

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

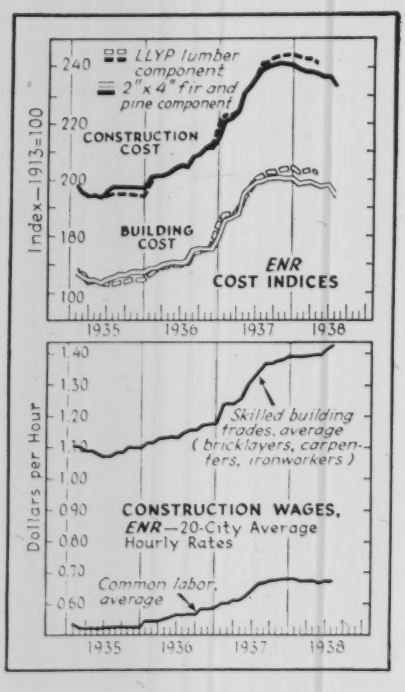
NEW PRODUCTIVE CAPITAL

	Cumulative 1937 27 Wk.	1938 27 Wk.
NON-FEDERAL	$640,272	$1,155,725
State & Mun. bonds	285,036	353,410
Corporate securities	282,982	191,938
PWA loans, grants	42,315	232,516
RFC loans	29,939	65,291
U.S.H.A. loans	.....	111,070
Federal Aid-Highways	.....	201,500
FEDERAL	.....	$1,068,032
TOTAL CAPITAL	$640,272	$2,223,757



ENR INDEX NUMBERS

	Construction Cost		Building Cost		Volume	
Base = 100	1913	1926	'13	'26	'13	'26
July 1938	233 10	112 05	195 20	105 52		
June 1938	236 86	113 86	198 22	107 15	165	72
May 1938	236 80	113 83	197 86	106 95	167	73
July 1937	239 90	115 10	199 80	108 00	187	82
June 1937	237 25	113 80	199 20	107 85	246	108
1937 (Av.)	234 71	112 66	196 15	106 07	172	75
1936 (Av.)	206 42	99 15	172 18	93 14	185	81
1935 (Av.)	196 44	94 43	165 76	89 65	134	59



THE MONTHS' SCOREBOARD

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	June 1937	June 1938*	% Change	Six months 1937†	Six months 1938	% Change
Total Construction Volume	$274,399	$223,066	−35.0	$1,245,428	$1,254,931	+3.0
Private	146,078	49,158	−73.0	640,258	487,501	−27.0
Public	128,321	173,908	+8.0	605,170	767,430	+22.0
Federal	20,372	21,540	−16.0	92,653	119,921	+24.0
Total New Productive Capital	$40,252	$504,566	+903.0	$598,073	$1,069,452	+72.0
Private Investment	38,786	170,742	+252.0	525,819	529,897	+3.0
Federal (Non-Federal work)	1,466	284,771	+14,560.0	72,254	403,970	+437.0
Federal (Federal work)	.....	49,053	.....	.....	135,585	.....
FHA Mortgages Selected for Approval	$55,185	$106,600‡	+54.0	$334,179	$464,489‡	+33.5

* Five-week Month. † 25 weeks. ‡ Preliminary report.

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	July 1937	July 1938	% Change	1937 June	1937 July	%	Change June to July 1938 June	1938 July	%
ENR Construction Cost Index, 1913 = 100	239.90	233.10	−2.8	237.25	239.90	+1.1	236.86	233.10	−1.6
ENR Building Cost Index, 1913 = 100	199.80	195.20	−2.3	199.20	199.80	+0.3	198.22	195.20	−1.5
ENR 20-CITIES' AVERAGE									
Common Labor	$0.662	$0.677	+4.4	$0.644	$0.662	+2.8	$0.677	$0.677	0
Skilled Labor (Av. 3 trades)	1.348	1.426	+5.8	1.327	1.348	+1.6	1.415	1.426	+0.8
Bricklayers	1.441	1.519	+5.4	1.437	1.441	+0.3	1.511	1.519	+0.5
Struct. Ironworkers	1.381	1.473	+6.6	1.343	1.381	+2.8	1.460	1.473	+0.9
Carpenters	1.221	1.288	+5.5	1.202	1.221	+1.6	1.275	1.288	+1.0
Cement, per bbl.	$2.53	$2.55	+0.8	$2.53	$2.53	0	$2.55	$2.55	0
Reinforcing Steel, Pittsburgh	2.55	2.05	−19.6	2.55	2.55	0	2.45	2.05	−16.3
Struct. Steel, Pittsburgh	2.25	2.10	−6.7	2.25	2.25	0	2.25	2.10	−6.7
Sand, per ton	1.17	1.25	+6.8	1.17	1.17	0	1.27	1.25	−1.6
Lumber, 2x4 Fir, per M	37.90	31.32	−17.4	38.31	37.90	−1.1	31.49	31.32	−0.5
Lumber, 2x4 Pine per M	33.15	27.62	−16.8	34.63	33.15	−4.3	27.47	27.62	+0.5
Brick, common, per M	14.24	13.79	−3.2	14.20	14.24	+0.3	14.14	13.79	−2.5
Ready-mixed Concrete c.y.	7.32	7.20	−1.6	7.30	7.32	+0.3	7.19	7.20	+0.1
Struct. Clay Tile, 3x12x12	74.05	74.32	+0.4	74.05	74.05	0	73.74	74.32	+0.7
Paving Asphalt, cars, ton	17.32	15.64	−9.7	17.27	17.32	+0.3	16.05	15.64	−2.5

MATERIAL SHIPMENTS . . . BUILDING PERMITS

	June 1937	June 1938	% Change	May 1938	% Change May-June
Lumber (% 1929 wk. av.) NLMA	77.0	55.0	−28.6	56.3	−2.3
Steel (% operating capacity) AISI	76.2	27.2	−64.3	29.4	−7.5

	May 1937	May 1938	% Change	Five Months 1937	Five Months 1938	% Change
Fabricated Struct. Steel (AISC)	140,525	90,942	−35.3	632,438	457,101	−27.7
Cement, thous. bbl., (USB of M)	11,890	9,752	−17.9	39,893	34,654	−13.1
Building Permits, Dun & Bradstreet, (,000 omitted)	$98,371	$77,656	−21.1	$491,430	$439,973	−10.5

RENT INDEX . . . EMPLOYMENT

	May 1937	May 1938	% Change	Apr. 1938	% Change Apr.-May
Rent (Housing) Index, NICB	86.1	87.0	+1.0	87.2	−0.2
Trade Unions, % Employed, AFL	89.0	81.0	−9.0	80.0	+1.0
Building Trades, % Employed, AFL	78.0	62.0	−20.5	61.0	+1.6

One Bay Ferry Is Suspended

California Railroad Commission refuses to increase fares of Oakland ferry

The California Railroad Commission in a decision delivered June 27 ordered the San Francisco-Sausalito ferry line to discontinue service within ten days after July 18. The commission acted at the request of the Golden Gate Bridge and Highway District, owners of the Golden Gate bridge.

At the same time the commission refused a request of the California Toll Bridge Authority, owner of the San Francisco-Oakland Bay bridge, to compel the San Francisco-Oakland ferry to raise its auto fare from 30 cents to 50 cents. This is the same rate which applies on the Bay bridge, and its adoption by the ferry, it was generally agreed, would have been tantamount to suspending service.

Both ferry lines are owned by Southern Pacific Golden Gate Ferry, Ltd.

The Sausalito ferry

In ordering the abandonment of the San Francisco-Sausalito service, the commission took into account the fact that the Golden Gate bridge is not now receiving sufficient returns from tolls to service its bonds; the bonds are secured by the tolls and by the real estate within the bridge and highway district. Also taken into account was the fact that, with its present tolls of 30 cents one way and 50 cents round trip, as compared with the 50 cents bridge toll, the ferry line is steadily losing money.

The situation is considerably different as regards the competition between the Oakland ferry and the San Francisco-Oakland Bay bridge. The Toll Bridge Authority contended that if the ferry fares were raised to parity with the bridge, thus ending ferry service, it would be possible to reduce tolls at once to 40 cents rather than waiting until September, 1940, to come down to this level.

The commission found, however, that there was strong public sentiment for continuing the existence of the ferry line, both for scenic and other values and as a standby service to the bridge. They also found that the ferry line was operating at a profit and that the bridge likewise was able to service its bonds from present tolls and will be able to reduce tolls in due course.

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Mellon Institute to Study Steel Mill Pollution

A fellowship has been established at Mellon Institute of Industrial Research in Pittsburgh to study methods for the abatement of stream pollution from such iron and steel mill operations as pickling. The fellowship was established through the American Iron & Steel Institute, and investigations, it is stated, will be carried on until concluded to the satisfaction of health and industrial authorities.

The objective will be a method of treating waste liquor of pickling plants to render it entirely safe for discharge into streams, and at the same time recover useful chemicals.

Willard W. Hodge, professor of chemical engineering, head of the department of chemical engineering and director of the engineering experiment station at West Virginia University, has been granted a year's leave of absence to head the investigation.

Flood Control Bill Is Signed

President regrets planning procedure in bill but approves of new power policy established

President Roosevelt "with some reluctance" signed the $386,500,000 omnibus flood control bill June 28. The bill authorizes, but does not appropriate, funds for a large number of flood control projects. It also introduces a new policy of eliminating all local contributions for dams, reservoirs, and channel improvements for flood control, other than local protective works, the federal government holding title to all lands, flowage rights, and rights-of-way.

In signing the bill, the President expressed his approval of this latter feature as "an improvement in jurisdictional control over properties involved, and a more adequate control over consequential power."

Planning method

The bill, however, "is not a step in the right direction in the setup provided for general government planning," the President said.

"I am in doubt as to the value of some of the projects provided for, and it is unwise to place recommendations to the Congress solely in the hands of the Engineer Corps of the Army in some cases and of the Department of Agriculture in other cases.

"Coordination of all such public works involves a wider survey and the examination of more national problems than any one bureau or department is qualified for.

"In these respects future legislation will be vitally important. . . ."

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN JUNE, 1938

Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Five Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States June 1938	United States Six Months 1938	United States Six Months 1937	Canada
Waterworks	1,485	271	278	485	481	617	**3,617**	47,691	42,249	78
Sewerage	242	5,710	124	1,616	2,288	1,096	**11,076**	52,456	49,921	2,080
Bridges, public	293	844	1,332	1,968	1,835	256	**6,528**	40,619	62,136	465
Earthwork and waterways	38	1,763	397	1,642	12,997	4,066	**20,903**	116,377	50,262	932
Streets and roads	3,151	16,816	14,734	12,166	21,898	18,035	**86,800**	271,907	179,326	5,545
Buildings, public	726	7,966	2,631	3,858	2,440	4,522	**22,143**	169,504	155,992	1,160
Unclassified, public	641	9,998	439	2,329	1,371	8,063	**22,841**	68,876	65,284	557
Total public	**6,576**	**43,368**	**19,935**	**24,064**	**43,310**	**36,655**	**173,908**	**767,430**	**605,170**	**10,817**
Federal government (included in above classifications)	240	5,649	2,317	1,250	2,189	9,895	**21,540**	119,921	92,653	.....
Private										
Bridges, private	.....	89	.....	.....	.....	.....	**89**	4,338	4,286	.....
Buildings, industrial	712	2,670	3,530	920	850	738	**9,420**	88,934	289,722	480
Buildings, commercial	1,785	19,649	2,319	4,549	1,350	4,140	**33,792**	345,895	243,311	1,317
Unclassified, private	153	1,653	295	1,053	947	1,756	**5,857**	48,334	102,939	.....
Total private	**2,650**	**24,061**	**6,144**	**6,522**	**3,147**	**6,634**	**49,158**	**487,501**	**640,258**	**1,797**
Total Engineering Construction										
June, 1938 (5 weeks)	**9,226**	**67,429**	**26,079**	**30,586**	**46,457**	**43,289**	**223,066**	.....	.....	**12,614**
May, 1938 (4 weeks)	11,538	83,356	18,142	22,486	27,531	20,753	**183,806**	.....	.....	5,090
June, 1937 (4 weeks)	11,034	147,787	25,705	29,859	36,226	23,788	**274,399**	.....	.....	9,506
Six months — 1938	55,405	538,941	123,778	150,544	214,235	172,028	.....	1,254,931	.....	40,947
Six months — 1937	59,347	601,303	110,664	184,020	169,116	120,978	.....	.....	1,245,428	61,577

Contractor Defeated In Tunnel Case

Damages denied to Six Companies of California in Broadway low-level tunnel suit

The U. S. District Court at San Francisco has denied the claim of Six Companies of California for damages of $3,260,000 from the Joint Highway District No. 13 in connection with construction of the Broadway low-level tunnel at Oakland, Calif.

The contractor, who abandoned work on the tunnel in June, 1936, claiming that ground conditions were not as represented, sought $3,260,000 from the district in repayment for the amount it spent on the project in addition to the $2,021,000 received.

At the trial the contractor presented testimony to show that although a geologist's report obtained by the district indicated that self-sustaining ground would be found, such ground was not found, and the specifications on timbering were thus made useless.

The district contended that the geologist's opinion and other advance data made available before the work started were not guaranteed, and that the contractor was responsible for verifying any information he wished to use.

In its decision the court held that the geologist's report was not a part of the contract and that the contractor had exceeded his rights in abandoning the job.

No decision has yet been made on a cross claim brought by the district demanding payment from the contractor of $383,000. This claim covers repayment of costs incurred in the completion of the tunnel in excess of the contract price, plus a $500 per day penalty for delay in completion.

History of the suit

The Joint Highway District No. 13 of the state of California, which was formed to carry out the Broadway tunnel project, awarded the contract to Six Companies of California in May, 1934, for $3,684,000. The contract called for completion of the project by May 24, 1936, with a penalty clause of $500 per day.

The project involves a concrete-lined tunnel creating a low-level highway 2,910 ft. from Oakland to rural districts east of the Berkeley Hills.

The work involved serious accidents and long delays in construction which the contractor attributed to heavy ground and which the district claims were due to the contractor's methods; differences arose between the district and the contractor. On the completion date set in the contract, the work was 70 per cent finished, and the district began deducting the prescribed penalty of $500 per day from the payment.

On June 13, 1936, the contractor quit the job, claiming the district had broken its contract and had thereby released the contractor from further responsibility. The contractor filed suit in July of that year, and while the suit was pending the district completed the tunnel under subsequent contracts totaling $1,751,000. The tunnel was opened to traffic Dec. 5, 1937. (*ENR*, Dec. 16, 1937, p. 966.)

ENR staff photos

NEW JERSEY FLOOD DAMAGE

THE BREAK in an old dike at Burlington, shown above, flooded that city but caused little property damage. Typical of highway damage is the washout of the Burlington County road, below, at a small culvert.

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State Wants Sales Tax On Municipal Water

State Auditor Smith of Missouri filed a mandamus action in the State Supreme Court June 25 to compel Kansas City to begin collecting the state sales tax on sales of water.

Kansas City in the past has refused to collect the tax, contending that the water service is properly a municipal function. Smith estimates that more than $100,000 is due the state in uncollected back taxes, but he has made no attempt to collect these.

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Surety Completing Project Held Not Taxable

A bonding company is not liable for business taxes on a project finished after default of the original contractor, it was held in Thurston County superior court at Olympia, Wash. The United States Fidelity & Guarantee Co. had brought suit for the return of an occupation tax paid under protest on its operations in finishing a highway contract.

The court held that the surety contract with United States Fidelity contains no specific mention of the occupation tax. The clause in the bonding agreement requiring observance of all state laws in completing the contract could not be construed, the court held, to require that the surety pay the occupation tax. The state tax law itself mentions the contractor but makes no reference to surety.

Heavy Rains Flood South Jersey

Deluge in flat country breaks small dam at Burlington and washes out numerous bridges

A downpour of 4½ in. of rain in 24 hr. flooded the flat, sea-level country of southern New Jersey on June 26-27, causing considerable damage to county roads and highway bridges, and washing out an old earth dike that created a diversion lake at Burlington, releasing some 75 million gal. of water upon the city.

As the city of Burlington, on the Delaware, is below high tide level and has to pump all storm and sanitary sewage, an earth dike about 1,000 ft. long and 20 ft. high was built 40 years ago to divert drainage from Sylvan Lakes, back of the city, to another water course that bypassed the city. This dike, creating a small lake, was overtopped because of insufficient outlet capacity in the lakes, and released the lake waters down the original drainage way through town. City engineer Samuel R. Probasco reports that, despite the deep flow of water through the streets, damage was limited to cellar flooding and the cost to the city of pumping the water over the riverfront levee.

County roads and bridges were washed out in Burlington County. Road supervisor L. A. MacFarland says the main damage to the county road system is loss of several miles of gravel shoulders, just completed and ready for oiling. The floods overtopped and washed out roads at many small culverts that were inadequate to carry the discharge according to F. L. Brannin, county engineer. A few old timber bridges were swept away, and fills behind abutments on newer structures were washed out. Damage on the state highway system was restricted to undermining of concrete slabs at a few points and erosion of cut slopes.

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Wooden Bridge Burns In Quebec

A 400-ft. covered vehicle bridge of timber across the Chaudiere River at Valley Junction, Quebec, was destroyed by fire on June 27. The fire, which destroyed the structure in about 4 hours, is believed to have been started by a lighted cigarette.

The bridge was only about 20 years old, having been built to replace a previous span carried away in a flood in 1917. Covered bridges are still being built in the rural districts of Quebec.

Berle Urges New York To Guard Water Power

A. A. Berle, Jr., assistant secretary of state in the federal government, on June 29 urged the New York State Constitutional Convention, now in session, to adopt the Poletti amendment on water power. The proposal, recommended by the Power Authority of New York State, declares that the ownership and control of power sites are vested perpetually in the hands of the people of New York and would permit the state to lease, license, sell or transfer water power sites only to a public corporation or other public agency.

Berle's statement concerned itself with the pending St. Lawrence River development; he said that action by New York State now would "guarantee that that development would be for the everlasting benefit of the people."

Berle charged that private exploitation of Niagara power had been inefficient and extravagant and he also charged that, by its control of American and Canadian utility companies, the Aluminum Co. of America plans to obtain control of the entire St. Lawrence power system. He implied that if the State of New York fails to assert its ownership of the St. Lawrence resources, the federal government will be forced by public opinion to assume control itself through an agency similar to TVA.

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Pauls Named to Head TVA Construction

A. L. Pauls, project engineer on TVA's Pickwick Landing Dam, now substantially completed, has been appointed chief construction engineer for the TVA with duties relating to all dam construction projects. In his new position, Pauls succeeds T. B. Parker, recently made chief engineer.

At the same time, George P. Jessup, construction superintendent on both Wheeler and Guntersville Dams, was advanced to the position of project manager of the Gilbertsville Dam.

Pauls started with the TVA in 1935 as construction engineer on the Pickwick Landing Dam, later being promoted to project engineer on that job. His more than 25 years of experience on heavy construction work before joining the TVA staff, included heavy construction for the Miami Conservancy District, irrigation dams with the Bureau of Reclamation, and hydroelectric projects for several utilities.

Jessup was for more than 25 years superintendent of construction for the Stone & Webster Engineering Corp., serving on many important projects.

Muskingum Dams Are Completed

Army turns over structures to Muskingum Watershed Conservancy District

The fourteen dams of the Muskingum Watershed Conservancy District were turned over to the district on July 1 by the U. S. Engineers, under whose direction they were built.

These fourteen dams form an integrated project for the protection from floods of an area in Ohio 100 miles wide and 140 miles long, fanning northward from Marietta on the Ohio River to the headwaters of the Muskingum, 25 miles from Lake Erie. This district, with a population of 675,000 people, has been severely flooded on a number of occasions.

Construction of the dams was made possible by a PWA allotment of $27,190,000 to the Muskingum Watershed Conservancy District, created in 1933 by the Ohio legislature. The Ohio department of highways contributed $8,920,000 for relocation of highways; the state advanced a grant of $2,000,000; and the district raised $6,000,000 in flood protection benefit levies.

The main reservoirs of the project are on the three principal tributaries of the Muskingum, the Walhonding River, the Tuscarawas River, and Wills Creek. With a total storage capacity of 1,559,000 acre-ft., these dams will reduce the flood crest of the Muskingum at Zanesville by 15 ft.

Construction of the reservoirs involved relocation of 65 miles of railroad, 140 miles of highway, 50 bridges, 65 miles of gas line, and 207 miles of telephone and telegraph lines.

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Buffalo Sewer Engineer Is Indicted

Clyde Potts, New York consultant, who was appointed engineer for Buffalo's $15,000,000 sewer project in 1935 and whose appointment was rejected by Administrator Ickes, was indicted on charges of first degree perjury by an extraordinary grand jury in Buffalo, N. Y., June 28. Potts pleaded not guilty and was released in bail.

Former Mayor George J. Zimmermann who is now out on bail pending his appeal from a conviction for bribery in connection with the sewer project, was indicted again by the grand jury on a charge of soliciting $25,000 from Greeley & Hansen, present engineers on the sewer project.

Potts' name was mentioned frequently during Zimmermann's trial.

A.S.T.M. Convenes In Atlantic City

Sessions and committee meetings devoted to materials specifications and tests occupy week

During a five-day meeting in Atlantic City last week some 1150 engineers interested in materials as users, producers or researchers listened to 104 technical papers and reports, voted upon standard specifications and tests, attended dozens of committee sessions, and otherwise advanced the knowledge and efficiency of the field in which they are interested.

The occasion was the forty-first annual convention of the American Society of Testing Materials, of which Prof. A. E. White of the University of Michigan has been president, giving way for the next term to T. G. Delbridge, manager of the research and development department of the Atlantic Refining Co. W. M. Barr, metallurgical engineer of the Union Pacific RR. was elected vice-president for a two-year term.

Three members of the Society were awarded honorary memberships, in accordance with a custom begun last year. These were Frank O. Clements, technical director, General Motors laboratories, Prof. W. K. Hatt, Purdue University, and Prof. H. F. Moore, University of Illinois. The annual Marburg Lecture was delivered by Albert Sauveur, professor emeritus, Harvard University. His subject was "The Torsion Test."

Recipient of the annual award of the Charles B. Dudley Medal was R. H. Heyer, research department, American Rolling Mill Co. The award was made for a paper delivered at last year's convention, "Analysis of the Brinell Hardness Test."

In his presidential address on "Organized Research," Prof. White urged continued and increasing encouragement and financial support for both fundamental and applied research. "Without the former," he reminded his hearers, "little ultimate progress can take place in the latter. Without the latter, little benefit can result to mankind from the former." Insofar as the A.S.T.M. is concerned, its committee on research reported, among others, the following activities as current or to be inaugurated: the effect on fatigue test results of the type of testing machine used; a study of methods of capping structural clay tile, at Rensselaer Polytechnic Institute; the effect of speed of testing, at the University of Illinois; and a study of adhesion testing of paint. The principal of the research fund was reported to have increased to $21,478 during the year.

With respect to the standardization activities of the society, the meeting witnessed the adoption of 77 new tentative standards, advancement of 33 specifications to standard and numerous other changes. The society now has 863 standard and tentative standard specifications and methods of test. The standards committee announced the formation of new committees on thermal insulating materials and on radiography and the resumption of work by the previously inactive committee on mortars for unit masonry. Consideration is being given to a committee on jointing compounds for such service as pipe, unit masonry and concrete roads.

T. G. DELBRIDGE
New president of A.S.T.M.

As an organization, the A.S.T.M. continues to grow. A net gain of 164 members during the past year swelled the membership total to 4,165, according to C. L. Warwick, secretary-treasurer. The technical program of the convention was featured by a symposium on impact testing. This and other developments of the meeting will be covered in next week's issue.

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Mexico to Guarantee Waterworks Loans

The Federal Public Health Department of Mexico is developing a plan to encourage private capital to invest in water supply systems for Mexican municipalities. Under the proposed plan, loans for water supply would be guaranteed by the federal government. The investment will be supervised by the National Urban Mortgage and Public Works Bank.

Cement Bids Received For Central Valley

Eight competitive bids were received June 30 by the Procurement Division of the U. S. Treasury for 75,000 barrels of finely ground standard portland cement to be used for Central Valley project construction in California.

The bids received ranged in fairly regular steps from $1.65 per bbl. offered by Pacific Portland Cement Co. to $2.20 per bbl. offered by Oregon Portland Cement Co. Every bid offered 10 cents each for returned bags. Bids were for cement f.o.b. point of manufacture or storage.

OBITUARY

VIVIAN R. MURWIN, 56, dredge superintendent at the Fort Peck dam project in Montana, died June 25 in Fort Peck. Capt. Murwin, who had been working as dredge master and dredge superintendent since 1906 throughout the United States, went to work on the Fort Peck project in 1934 as dredge master of the dredge *Gallatin*. A year later he was given the position of superintendent of dredging in charge of all four dredge units at the dam.

FRANK R. COATES, 69, president of the Toledo Edison Co. and at one time chief engineer for the Chicago Great Western R.R., died June 26 at Avon, N. J. Coates, a graduate of Lehigh University, did his first engineering work for the Baltimore & Ohio and later went with the New York, New Haven & Hartford.

GORDON B. RAYMOND, construction engineer, who did work on the Ford plant in Dearborn, Mich., died June 20 in Los Angeles at the age of 59.

CHARLES C. HANSEN, a member of the engineering staff of the Ingersoll-Rand Co. for nearly 40 years, who had done much work in the development of rock drills, died in Easton, Pa., June 29, at the age of 69.

HERBERT S. CLARK, for the past seventeen years engineer of maintenance of way for the Delaware & Hudson R.R., died in Boston June 23.

FRANCIS D. CHRISTHILF, 51, engineer and highway contractor of Maryland, died in Baltimore June 16. Before entering contracting work, Christhilf was an engineer for the Maryland Geological Survey from 1905 to 1909 and for seven years thereafter assistant engineer with the Baltimore Sewerage Commission. Christhilf was a past president of the Maryland Highway Contracting Association.

Balcom Dies In New York

Structural engineer, 68, was designer of many notable skyscrapers in New York

Homer Gage Balcom, one of the country's outstanding engineers in the field of steel building design, died in New York Sunday night, July 3, of a heart attack, at the age of 68. In a career devoted to structural engineering he had designed the frames of many of the largest buildings of the last thirty years, and had been consulted on important steel construction abroad as well as in the United States.

A native of New York state, Balcom spent a few years in teaching before taking up the study of engineering. Soon after graduating from Cornell in 1897 he entered structural engineering practice as draftsman and designer for the Berlin Iron Bridge Co., East Berlin, Conn.

After ten years' experience in mill building and tier building design with this company and its successor, the American Bridge Co., he was retained as designing engineer for the new Grand Central Terminal, the passenger terminal of the New York Central Railroad, then being constructed at New York. The steelwork of the station and office buildings, and the extensive street support and building structures covering the Grand Central yard area, were almost wholly his work. In this huge undertaking, which extended over many years, he had to work out not only serious structural and foundation difficulties but also solve the problem of insulating the building frames against transmission of vibration from the track and street steelworks, by independent foundations, vibration-absorbing mats in the footings, and vertical separation between building and traffic frames.

With the large growth of skyscraper construction, Balcom's designing and consulting practice assumed large proportions, extending to the design or the review of design of many of the tall building projects undertaken in New York City and elsewhere. Most prominent among his later works are the buildings of Rockefeller Center, including the 832-ft. RCA building, with 58,500 tons of steel, and the 1,250-ft. Empire State building, with 57,000 tons, whose extreme proportions led to special studies to limit lateral deflection and oscillations as well as vertical compression. He also designed the framework of a number of the new government buildings in Washington, including the Commerce building, the Post Office, and the Archives building.

A noteworthy part of Mr. Balcom's contribution to structural engineering was his service during the war as chief structural engineer of the American International Corp. in fabricated-ship construction at the Emergency Fleet Corp. yard at Hog Island, Pa. Here he applied his thorough command of design principles and fabricating shop practices to design of frames and hull plating of the 10,000-ton freighters for rapid and economical fabrication at scores of bridge shops throughout the country in such precision as to permit of direct assembly and riveting at the yard without fitting and drilling.

In a lifetime of structural engineering practice, interrupted only by the two years of Hog Island activity, Mr. Balcom won the esteem of his professional colleagues, his clients and of building interests generally by his integrity as well as by his insight, skill and good judgment. He was able also to impress the same qualities on his fellow workers, who for some years past have been joined with him in the firm of H. G. Balcom & Associates.

Participating actively in technical and professional society work, Mr. Balcom served on a number of important committees of the American Society of Civil Engineers and other organizations, was president of the New York County Chapter of Professional Engineers during three terms, and was a director of the New York State Society of Professional Engineers. He also took an active part in the civic affairs of Hastings, N. Y., where he lived, and for many years was president of the local Board of Education.

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Johnson Is Named Dean At Wisconsin

F. Ellis Johnson, for the past three years dean of engineering at the University of Missouri, has been appointed to head the engineering department at the University of Wisconsin.

Johnson, who is now 53 years old, graduated from Wisconsin in 1909 in electrical engineering and worked for several years in the Pacific Northwest in power plant construction, later practicing as a consultant. In 1912 he went to Rice Institute to teach engineering, and after three years there he went to the University of Kansas. In 15 years at that institution he rose from the position of instructor to head of the department of electrical engineering.

In 1930 Johnson was made head of the department of electrical engineering at Iowa State College. He went to the University of Missouri to head the college of engineering there in 1935.

Investigators Attack Road Department

Improper purchasing and contract letting by Illinois highway department is found by committee

The purchasing body of the Illinois state highway department is either unable or unwilling "to take advantage of free, open competitive bidding as a means of most economically expending funds," according to a committee of engineering professors appointed by Governor Davey last fall to investigate the highway department. "The abuse of general bids in the purchase of transit-mixed bituminous concrete," the committee found, "has been such as to constitute a breach of trust in the expenditure of public funds." The committee was appointed by the governor when charges of improper purchasing procedure first began to be heard in the Illinois legislature.

Two days later, the Franklin County common pleas court granted a temporary injunction against payment to a number of bituminous concrete firms of amounts due them pending the outcome of a taxpayers' suit brought by Mrs. Agnes Dickinson.

In its findings in relation to bituminous concrete, the committee found that "in specific instances" the department has paid excessive prices.

The committee found that price fixing seems to exist among certain bidders on cement, drain tile, and gasoline. Friction was found between federal and state highway authorities.

Manipulation of contract awards in some instances by the highway department was charged by the committee, and many contracts were stated to have been let without complying with the law.

Payment withheld

In granting the injunction against payment of sums amounting to $159,000, the common pleas court pointed out that evidence so far brought forward in the Dickinson suit supported the charge that at least some of the defendant members of the state highway department have knowingly aided the Hot-Mix Bituminous Industry of Ohio, Inc., and its member firms in restricting competition and in securing excessive prices for hot-mix materials during the years 1935-1937.

The suit brought by Mrs. Dickinson charges that fraud and conspiracy between the hot-mix firms and the state highway department has defrauded the state of $3,000,000. Under the double indemnity clause of the state anti-trust act, she seeks to recover $6,000,000.

LABOR NOTES

LABOR CONDITIONS at the Deer Creek project in Utah were stabilized last month when, at a meeting in Washington between officials of the U. S. Department of Labor and of A.F.L. and C.I.O. unions, the unions agreed to accept the wage scale fixed for the project by the U. S. Department of Labor. This scale is based on a wage for common labor of 65 cents an hour and agrees on most points with the scale established by the Utah Industrial Commission for public works in the state. The Rohl-Connolly Construction Co. is the contractor on the project, on which construction work recently got underway.

SETTLEMENT on June 29 of a controversy between the city of St. Louis, Mo. and operating engineers in the city water department averted the threat of a halt in water service which had been hanging over the city for a week or more. The engineers' union called a strike for June 21, but the strike was postponed several times and an agreement on the points in dispute was reached June 29. The union wanted the city to hire four additional engineers. A previous agreement provided for a 42-hr. week and a 20-day vacation, but the union claimed that because of the insufficient staff engineers were working 16 hours every other day. Although the terms of the agreement which terminated the dispute were not revealed, the union stated that in the future the engineers would work only 42 hours and would receive the full vacation provided in their contract.

COMMON LABOR, too, gained a victory in the St. Louis area June 29 when the Common Laborers Union, Local 100, A.F.L., terminated a two-day strike by signing a contract with the Associated Builders of East St. Louis, Ill.

ALL CONSTRUCTION work at the New York World's Fair grounds has been halted by a general strike of the building trades called in sympathy with a strike of the International Brotherhood of Electrical Workers. The electrical workers are claiming the right to install telephone lines under roads through the fair grounds, holding that these roads are essentially private, while the telephone company wants to install these lines with its own forces, as it does on public highways outside the fair, holding that the fair roads are the same as city streets.

New Niagara Bridge Bill Withdrawn in Canada

The Niagara bridge bill has been withdrawn from the Canadian parliament after having passed the House of Commons (*ENR*, May 26, 1938, p. 735). The bill was sent to the Senate for consideration but was withdrawn June 28 at the request of the Ontario highway department.

The bill would have permitted the Ontario government, acting through a dummy corporation, to construct a new bridge.

Premier Hepburn of Ontario stated that the bill was withdrawn because the Ontario government would not yield to "coercion" from senators on the Senate Railway Committee who, he said, had attempted to force an agreement compelling the payment of a large sum of money as compensation to the International Railway Co., owners of the bridge which was carried out by ice last January.

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State Building Authority Set Up in Ohio

The Ohio State Legislature, in special session, passed on June 23 a bill providing for a $13,500,000 building program at various state institutions. In order to avoid debt limitations placed on the state under the constitution, the bill sets up a state building authority which will issue bonds and receive PWA grants to carry out the program. The buildings will then be rented to the state, the rent being used to pay interest and principal on the bonds.

Under the bill, the authority is authorized to issue $7,500,000 of bonds which, if matched by $6,000,000 of PWA funds would cover the entire program.

The bill is now awaiting the signature of Governor Davey, who has expressed his approval of the program.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Hotel Utah, Salt Lake City, July 20-22.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific Coast convention, Portland, Aug. 9-12.

LOCAL AND REGIONAL

WESTERN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Reno, Nev., Aug. 10–13.

AMERICAN WATER WORKS ASSOCIATION, Central States Section, Hotel Windsor, Wheeling, W. Va., Aug. 17-19.

Ohio Calls for Bids on First Big Cloverleaf

The Ohio Department of Highways will open bids on July 22 for the first big cloverleaf intersection in the state, at the re[illegible]ted junction of U. S. 21, Brecksville Rd., and S. R. 17, Granger Rd., Cuyahoga County. The intersection will be located in the present Cuyahoga River bottoms, which calls for a new channel for the river. New Granger Rd. will cross the river on a new bridge, pass under Brecksville Rd. and pass over the B. & O. RR. tracks. The relocated Brecksville Rd. will cross over the B. & O. RR., and over Granger Rd. on separate structures, and then cross the new river channel, another branch of the railroad, the Ohio canal and Canal Rd. on a new five-span bridge. An extension of Granger Rd. will require another bridge over the canal.

The work has been divided into four proposals: (1) All pavement construction; (2) grading, channel work and the highway intersection structure; (3) the two river bridges and canal crossings; (4) the two main line railroad crossings. Bids will be received on any of the four proposals or any combination of the four. The engineers' estimate is $1,702,000 for the complete job. Principal quantities include: Excavation, 410,000 cu. yd.; embankment, 881,000 cu. yd.; concrete base and pavement, 64,000 sq. yd.; brick surfacing, 81,000 sq yd; concrete, 11,000 cu. yd.; reinforcing and structural steel, 3,775,000 lb.

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Road Exhibit Planned At Santiago

An international highway exhibition is to be held in connection with the third Pan American Highway Conference in Santiago, Chile, in January 1939, it has been decided. The exhibit will start in December of this year and will remain open for 45 to 60 days.

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Wisconsin's Little TVA Upheld by Court

Reversing a previous decision, the Wisconsin supreme court on June 21 held that the Wisconsin Development Authority, popularly known as the little TVA, is constitutional. The court held that the quasi-public corporation, established by the 1937 legislature, may receive a $120,000 appropriation from the state for developing hydro-electric power. But it held that the authority may not use the money for assistance to communities in establishing municipal ownership.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Butt Welds Defended

Sir: It seems to me that your editorial "Welding Not Discredited" (*ENR*, May 5, p. 642) is very unfortunately worded. The phrase, "It cannot be said that welding as such is discredited by the failure", has much the flavor of "It has not been proven that he was drunk and disorderly and beat his wife." Surely this is damning with faint praise.

Further the phrase, "the use of butt welds is placed under a suspicion", although it does not say so, leaves the impression that other forms of welds are to be preferred to butt welds. This of course is not so. Wherever the structure can be designed to permit the use of butt welds they are to be preferred to any other form of fusion weld.

Finally where is the "mystery" of "this unfortunate failure"? Not even the most ardent advocate of fusion welding would be surprised at the failure of a structure in which the welds showed "poor quality of work, which should have been detected by inspector".

L. B. TUCKERMAN,
Asst. Chief
Mechanics and Sound Division
National Bureau of Standards
Washington, D. C., June 21, 1938

Sir: In the May 5, 1938 issue there was what seemes to me a rather unfortunate use of words in expressing an idea, namely that the "use of butt welds in tension is placed under suspicion". Butt joints provide the most efficient method of joining two plates together. Obviously, of course, there are times and places in structures where it is impossible to make a joint of this type, and other conditions therefore overcome the advantage to the extent that changes must be made. An example of the use of butt joints, without stress-relieving and under tremendous load is their use in oil well casings.

I fully realize the idea back of the statement, but on the other hand if the same method of presentation of facts were used in other cases, we would eventually have a condemnation of all manufacturing processes and materials. Undoubtedly, some time at some place or other, we are going to have failures as long as human activity is involved in the fabrication of a product. My viewpoint is that, first of all, any discussion of welding should be presented with the same degree of logic and carefulness as any other subject. Secondly, due to the fact that it is welding, and there exists in some quarters an inclination to avoid considering welding because of the lack of experience in welding, presentation must necessarily be most complete.

It is inadvisable and not correct to introduce any indication of suspicion that the use of certain methods of construction are questionable, when the facts do not so justify.

E. W. P. SMITH,
Consulting Engineer, Lincoln Electric Co.
Cleveland, Ohio, June 20, 1938

Cohesionless Soils

Sir: In an article in the June 16, 1938, issue on "Compacting Cohesionless Materials," Richards M. Strohl has given some extremely interesting and valuable data and has described practical methods for building stable structures of sand.

Mr. Strohl has made the general statement that the critical density of soils varies with the maximum attainable density, the grading of the material, and possibly with the size and shape of the soil grains. These physical relations can be defined more definitely as a result of research at Columbia University. It is believed that the *grading-density relations of cohesionless soils* are also fundamental because they give a better understanding of the above mentioned physical factors on density and therefore on the behavior of cohesionless materials. These relations are described in detail in Bulletin 6, "A Study of the Physical Characteristics of Soils with Special Reference to Earth Structures," Civil Engineering Research Laboratories, Columbia University, June, 1938, and "The Grading-Density Relations of Granular Materials," a paper by the writer before the recent A.S.T.M. meeting.

For each material there are three characteristic states of density: the maximum density, the critical density, and the loose condition. The loose condition is the least definite, depending on both the method of placing and the moisture content. For dry materials there is a characteristic spread between the loose and dense states, which, on the average, amounts to 8 to 10 lb. per cu.ft. dry weight, or an increment of about 6 to 8 per cent in the percentage of voids. The critical density varies from about 50 to 75 per cent relative density as defined by Prof. Terzaghi.

The density attainable for any given material in any of these characteristic states depends on the *type* of the distribution of particle sizes, and to an even greater extent on the *range* of particle sizes. The density is not greatly influenced by the degree of fineness of the material except in the quite fine sizes, where there is a tendency for decrease in density with fineness. For moist soils, bulking effects become more pronounced for the finer materials.

The influence of sub-angularity, and to a greater extent angularity, is to materially decrease the characteristic densities of materials, but probably there is a greater interlocking effect. The presence of micaceous material also materially reduces density. On the other hand, smooth, flat and elongated grains appear to produce greater density, greater than spherical particles, due probably to the orientation and close nesting of such particles.

Because of the fact that these physical relations are consistent, quantitative expression can be given to them in the grading-density relations.

Mr. Strohl's article has opened up and brought to the attention of engineers a subject which is of great practical significance. The results of these investigations, together with the practical experiences gained in actual construction, will do much to place the design and construction of earth structure of cohesionless materials on a rational and scientific basis.

DONALD M. BURMISTER
Columbia University
New York City, June 20, 1938

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THE QUICK START that is being made in allocating PWA funds contrasts sharply with the fatal slowness of the corresponding procedure five years ago, when the depression was first being attacked by a public-works campaign. Already more than one-fourth of the PWA authorization has been approved and financed, and it looks as though by early fall the full impulse of some 1½ billions of added construction work will be effective. Such an aggressive campaign will of course put many more men to work. It will also mean a new chance for the starved contracting industry, revived markets for construction materials, and stimulus to transportation and other services auxiliary to construction. Additional momentum will be given to the campaign by repeated turnover of wage and supply payments. Altogether a decided recovery effect on industry, business and the individual citizen is in prospect. That little effect of this kind was noticeable in the 1933-35 period may be charged to the lagging, indecisive way in which the program was started. This time, fortunately, we are to see what speed can accomplish.

One Line of Advance

IMPORTANT NEW FACTS and new thought emerged from last week's meeting of the American Society for Testing Materials, as usual. Prominent among the suggestive contributions were Prof. Albert Sauveur's Marburg Lecture argument in favor of the torsion test as basic quality test for metals; new studies of fatigue, which, by suggesting that damage and repair proceed simultaneously in a bar subjected to repetitive stressing, may compel revision of present ideas on the causes of endurance failure; and, as a particular sensation in these days of intensive soil study, a new method for investigating soil behavior by measuring the energy absorbed in agitating or kneading soil. But metal and earth were by no means the only subjects of important contribution to knowledge; virtually every one of the numerous materials discussed at the meeting provided a stimulus to forward thinking. In brief, the meeting once more demonstrated vigorous growth of knowledge in the field of materials.

Dynamic Soil Study

EXPLORATION of the behavior of soil under static tests is extended in a highly promising way to non-static conditions by a new method of investigation reported at the A.S.T.M. meeting by E. O. Rhodes, of the Koppers Co. A soil sample is kneaded in a pug-mill mixer while water is added at a slow but constant rate, and the relation between the kneading torque (which with constant-speed drive is proportional to energy absorbed in the process) and water content is charted automatically. Surprising variations and irregularities of the resulting curves point to differences between different soils that may be related to phenomena encountered in practice. Some correlations with static test characteristics of the soil have already been established, although the work with the new method has proceeded but a few weeks. Present prospects are that an extensive new field of observation will be opened up by the application of this dynamic method of soil study, and that the past twelve years' progress in investigation of soil behavior will be further accelerated.

Science Brought to Aid

THE PROBLEM of soil stabilization for road bases and subgrades has been most commonly attacked by methods of trial and error, particularly where stabilization was undertaken by processing the natural soil with an artificial binder. Bases and subgrades have been constructed in the field with trial binders of various sorts, applied in various ways and proportions, and the defects of the resulting structure have been observed for correction of subsequent practice. While laboratory supervision has had its place in all these trials, essentially the result depended on experimentation rather than on fundamental research. It is in the clearer conception of the research element that the study of soil processing with cement outlined in this issue and preceding issue of *Engineering News-Record* is highly significant. Aside from the practical rules of procedure developed, the work of the laboratory of the Portland Cement Association is far-reaching in its proof that the complexities of processing soil can be made almost completely amenable to scientific direction. If the Sheets and Catton report of laboratory study had no other value than to demonstrate this one truth, the work described

would be of outstanding service to soil knowledge in general as well as to roadbuilding.

More Research Support

LABORATORY INVESTIGATION combined with trial of the research findings in actual road construction as carried out by the Portland Cement Association engineers strengthens the position of research by a much-needed demonstration of its practical value. Field men often look on laboratories as detective agencies rather than as discoverers and pilots. It is true that better understanding of the "testing laboratory" is coming about, but the older view still remains too common. Money and man power for research is almost the last thing that the highway executive is willing to approve. Roadbuilding research cries aloud for support. No better proof is needed than is furnished by the soil-cement studies, though there is no lack of other examples. After three years of investigation resulting in highly useful determinations, the experimenters are almost oppressed by the advances in precise knowledge that have yet to be made. The same lack can be found in every branch of highway engineering knowledge; the well supported highway laboratory is the only rescue from this state of imperfection and ignorance.

Look to Your Borings

AWARD of substantial damages to the contractor for a water tunnel because the engineer's borings were misleading serves to add new emphasis to the need for accuracy and the fullest amount of frankness between engineers and contractors with respect to preliminary exploration.

Test borings or test pits are a recognized essential to any major engineering operation. They are essential to the engineer in making his designs and in preparing his estimates; they are essential to the owner first as a means for determining what his costs are to be, and second as a means for obtaining reasonable bids from contractors. Why, then, it is frequently asked, do these very essentials to a construction operation so often become the center of costly litigation? Is there any way in which such litigation can be avoided?

On the first question it may be said there are not many cases in which litigation over borings has added to the cost of a project. For every contract that ended in a lawsuit there are hundreds which involved no litigation. Yet the fact remains that lawsuits challenging the results of advance exploration have caused a great deal of trouble and often have tended to cast doubt on the wisdom of carrying out construction by contract.

In answering the second question it is well to review what the courts have found in the more important cases involving preliminary investigations. The established view of the courts on the matter roughly appears to be this: The owner is responsible for unforseen costs to the contractor when the engineer's borings are found to contain inaccuracies or fraudulent misrepresentation. The owner also is responsible when the engineer does not reveal to the contractor his complete record of preliminary investigations even when he has reason to doubt their accuracy.

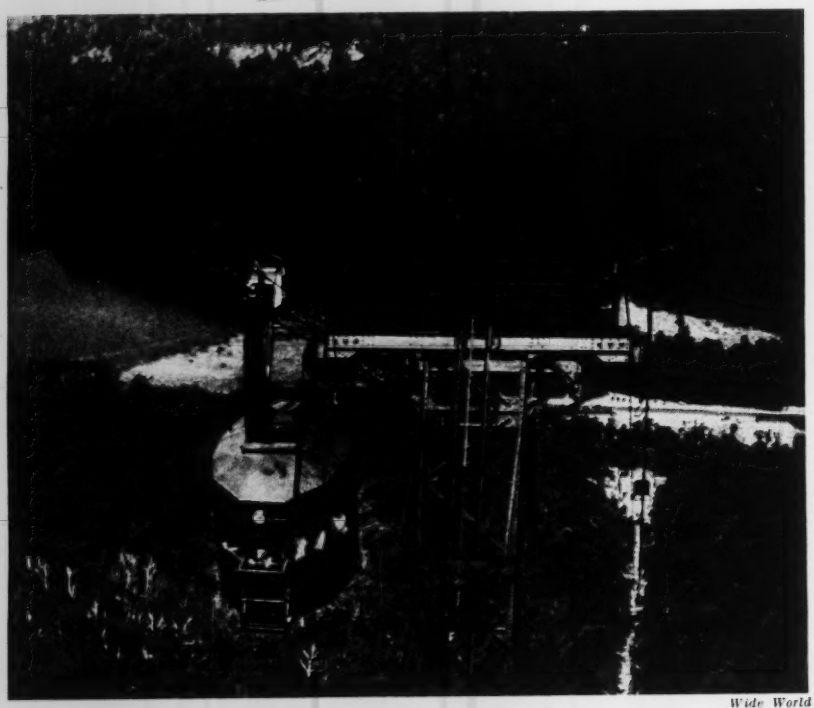
On the other hand, the owner is not responsible for the fact that incomplete borings do not reveal hidden ledges of rock in an earth bank, buried cribs along old waterfronts, and the like. The chance of finding such costly obstacles is part of the risk a contractor takes. He is supposed to have examined the site with the engineer's exploratory data before him, and is expected to base his bid on his own analysis of how accurately the borings show what he may encounter. Lower courts have penalized owners when unforeseen difficulties have caused the contractor to sue, but only under exceptional circumstances have higher courts ruled that the risk of such discovery is the owner's rather than the contractor's, provided always that there has been no concealment by the owner.

To avoid the trouble and expense involved in a lawsuit, the engineer needs only to be sure that his borings are comprehensive, are carefully made and accurately recorded, and that his complete record is made available to bidders. The elaborateness of the exploration is for the owner and his engineer to decide, the cost being weighed against the possible savings that can be obtained through fuller knowledge of underground conditions.

If the owner does not feel justified in making large expenditures for preliminary investigations the call for bids should make clear to the bidders that the information as to underground conditions is limited. Money can be saved at times by including excavation to a certain depth in the contract, making the remainder of the work subject to a cost-plus agreement.

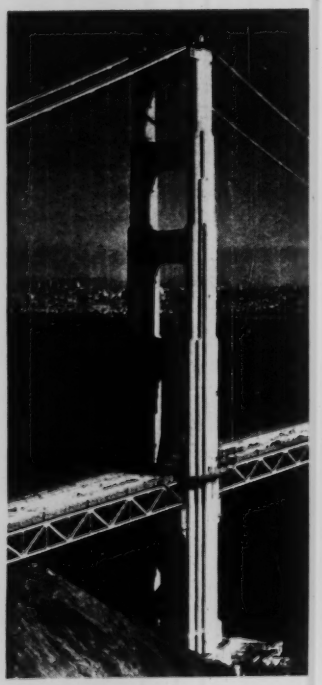
Superficially, the record of damages collected through attacks on the engineers records of borings would seem to indicate that it might be cheaper not to make any preliminary examinations of the site, thus putting on the contractor the whole responsibility for determining what the foundation costs will be. But of course that view is absurd; the losses due to the high bids that would have to be made to protect the contractors would be unwarrantable. Sound engineering calls for the maximum amount of preliminary study, and if the test borings are properly made and properly recorded, and if all are laid before the bidders on the work, the engineer need have little fear that they will lead to costly litigation.

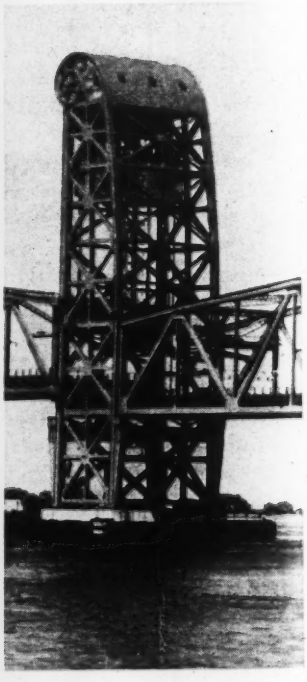
PICTURES IN THE NEWS



Wide World

MOUNTAIN CLIMBING the easy way. A 5½-minute ride in this new tramway takes the place of a two-hour hike to the top of Cannon Mountain at Franconia, N. H. The tramway cost more than $200,000. Its two cars, operating in opposite directions, each carry 28 people a slope distance of 5,410 ft. The difference in elevation of terminals is 2,007 ft.





MOST BEAUTIFUL BRIDGES OF 1937. Stainless steel plaques will be attached to these structures to signify their selection for this distinction by a committee of the American Institute of Steel Construction. The bridges are as follows: Left, Golden Gate Bridge, San Francisco; top center, Little Hell-Gate crossing of Triborough Bridge, New York City; bottom, center, Chesterfield-Brattleboro Bridge over Connecticut River, New Hampshire and Vermont; right, Marine Parkway lift Bridge, New York City.

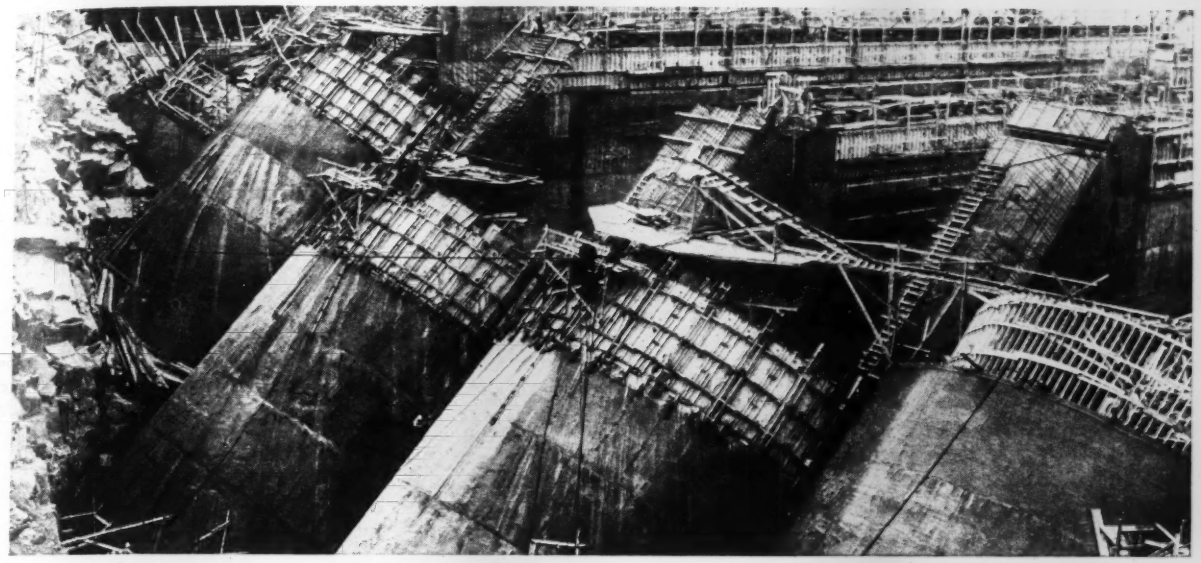


FIG. I. SPECIAL FORMS AND PUMPED CONCRETE CHARACTERIZE THE BUILDING OF BARTLETT DAM

Highest Multiple Arch Dam

Bartlett Dam, rising to record-breaking height of 287 ft. will store flood-waters of Verde River for Salt River irrigation project in Arizona

FIFTY-FOUR MILES north of Phoenix, Ariz., on the Verde River there is being built a multiple-arch concrete dam higher than any previous structure of its rather uncommon type and as modern in design and construction as present developments in the art can make it. Known as Bartlett Dam, it will rise 287 ft. above its foundations to impound 201,500 acre-ft. of seasonal flood waters in a 3,170-acre reservoir for release to the lands of the Salt River Valley irrigation project, thus supplementing the present supply which comes down the Salt River (of which the Verde is a tributary) through the four reservoirs formed by Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain Dams. Some of the stored water will also be used on the Salt River Indian Reservation, so that 20 per cent of the project cost is borne by the U. S. Indian Service, the remainder being defrayed by WPA repayment funds assigned to the Bureau of Reclamation, the agency responsible for design and construction.

The field work, which began in August, 1936, is scheduled to be completed in May, 1939. To date, features have included the design and handling of forms for relatively thin concrete sections with curving and sloping surfaces, placing 12,000 cu. yd. of concrete per month by pump line, the working out of a foundation grouting procedure that would not lift the light arches and in general the use of a number of minor but important methods peculiar to this special type of dam.

An uncommon type

In selecting a multiple arch for the Bartlett site, the Bureau chose a type of design with which it had had little previous experience but which careful investigation indicated was the most suitable and economical to meet the conditions. The multiple-arch dam, in fact, is not a common type, authoritative records listing only about 30 such structures in the world that exceed 100 ft. in height. Only three of these rise above 200 ft.—Castrola, Italy, 226 ft.; Tirso, Italy, 239 ft.; and Lake Pleasant, Arizona, 256 ft. Bartlett Dam, with a height of 287 ft., will thus be at the head of select company.

Multiple-arch dams, morever, have not enjoyed continuous popularity. Although the first such dam (Meer Alum in India) dates from over 100 years ago, it was not until about 1900 that one with a height of 100 ft. was constructed. In the next 25 years only four other "major" dams (over 100 ft. in height) were built, all in the United States. The decade 1920–30, however, recorded a world-wide sweep in popularity, and 23 major multiple-arch dams were constructed. Then another lull occurred and, in the current decade, only three multiple-arch dams have been added. One of these, the 145-ft. Hamilton Dam in Texas was finished last year,

so that, with the completion of Bartlett in 1939, we will have witnessed another small revival of interest in the multiple-arch dam.

Bartlett dam elements

Before choosing a multiple-arch dam for the Bartlett site, practically all available types were investigated, including a concrete arch, a concrete gravity section flat slab and buttress and earth and rockfill types. With respect to the latter, available fill material was found to be unsatisfactory, and there also was danger of overtopping from flash floods, a condition dictating an unduly large and expensive spillway. The concrete gravity section, the flat slab and buttress and the arch were largely ruled out on the score of their high cost. The lightweight reinforced multiple-arch dam, on the other hand, was very economical in material quantities and, while it entailed slightly higher design and construction costs than a gravity section or arch dam, it was believed to be the most efficient for the site.

As finally designed, Bartlett Dam is 750 ft. long, exclusive of the 170-ft. spillway, and is made up of ten arch barrel sections, the intervening buttresses and short gravity sections at each abutment. The buttresses, in the shape of truncated pyramids, have double walls 8 ft. apart. (Fig. 2). The upstream walls of the buttresses are 7 ft. thick at the bottom and 2 1/3 ft. thick at the top, with their interior faces made vertical as a construction expedient. The same decrease in thickness, from bottom to top, occurs in the arches which spring from these upstream walls. Downstream, the buttress walls vary from a 4½-ft. thickness at the bottom to 2 ft. at the top.

By placing the buttresses on radial lines, a constant value of 48 ft. for the intrados diameter of the arches could be obtained, which afford a construction advantage similar to that achieved by the vertical faces of the buttress walls. Another result of placing the buttresses on radial lines is that the dam axis is on a curve, which by slight adjustment makes the dam fit the topography to best advantage. Up and downstream face walls and vertical stiffener cross-walls complete the buttresses. Openings through the top and bottom of the stiffener walls and through the main side walls are provided to permit ventilation and assure a more uniform distribution of temperature. The arches have a total central angle of 180 deg. and a constant thickness in a plane normal to the springing line.

The spillway, for passing excess floodwaters around the dam, and the outlet works, for passing irrigation water through it, complete the essential elements of the dam structure. Cut through the rock of the north

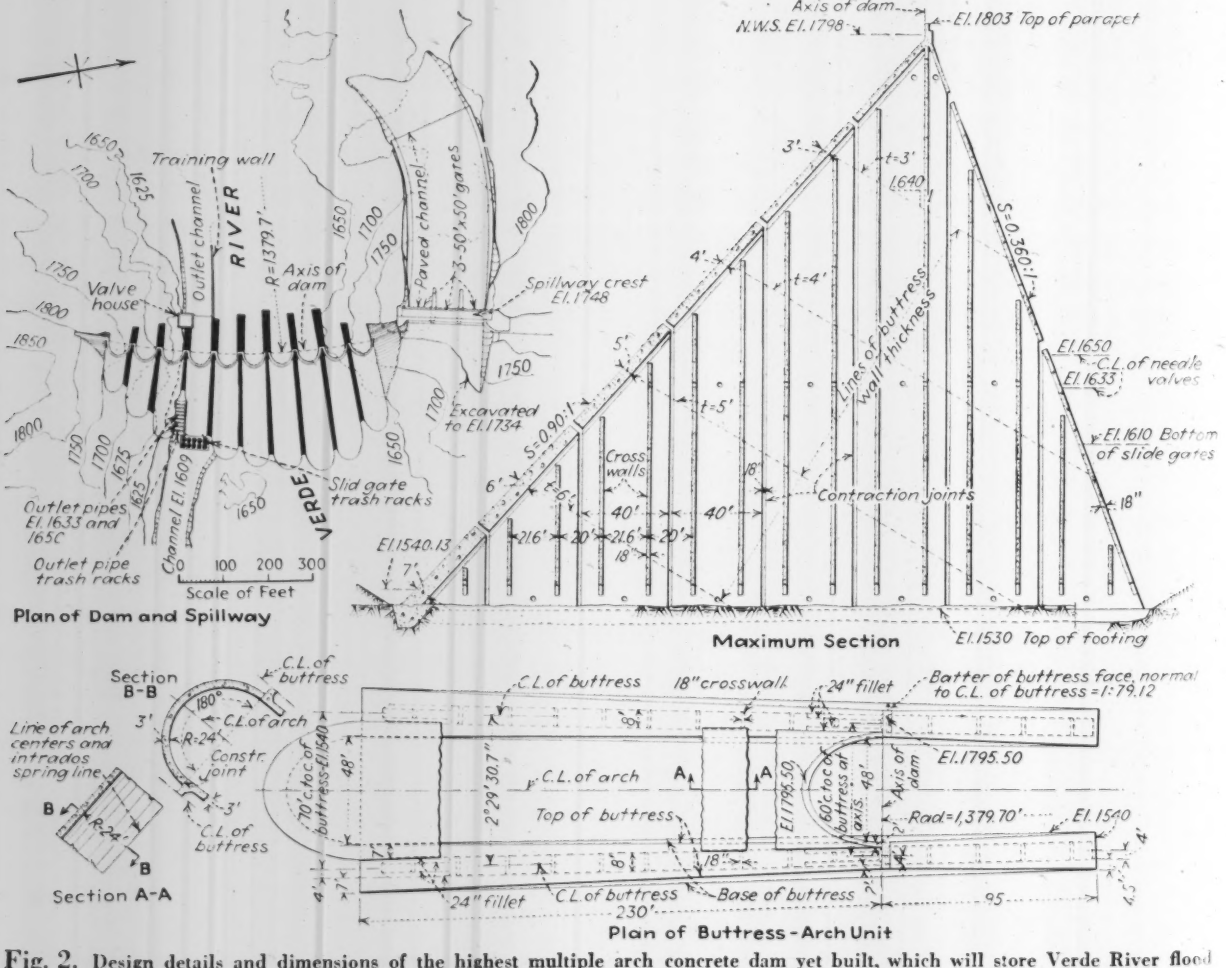


Fig. 2. Design details and dimensions of the highest multiple arch concrete dam yet built, which will store Verde River flood waters for the Salt River irrigation district in Arizona.

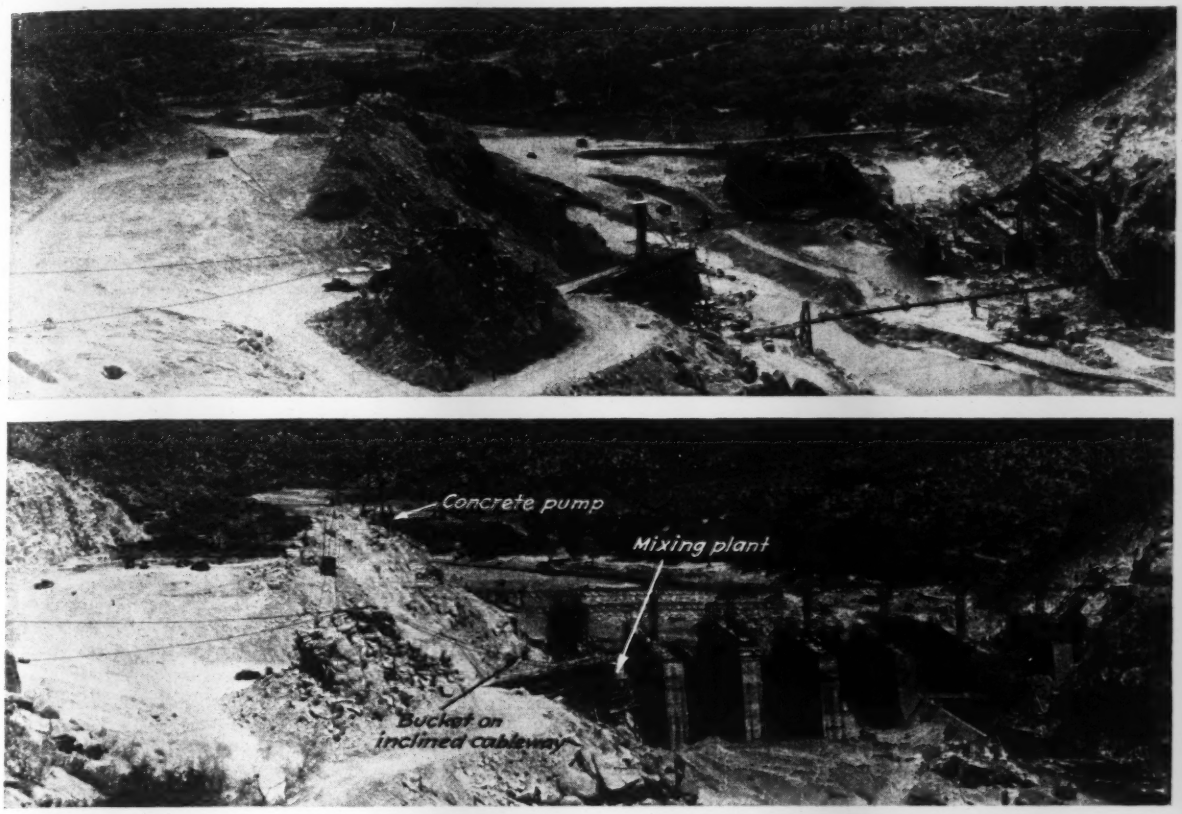


Fig. 3. Early and current stages of work. In top view, concrete is piped across the river on a suspension bridge. At bottom, it is handled in buckets to a pump machine at the top of the abutment from where it is piped across a construction bridge supported on the buttresses. The spillway cut is at the left in both views.

abutment, the spillway, equipped with three 50 x 50-ft. gates, consists of a 650-ft. channel (of which the first 350 ft. is concrete lined) curved both in plan and profile and superelevated on the horizontal curve designed for a 175,000 sec.-ft. discharge at normal full reservoir. It will discharge 225,000 sec.-ft. at maximum flood stage (El. 1807), at which time 25,000 sec.-ft. will also spill over the dam.

Three hydraulically-operated slide gates located in mass concrete under one of the arches near the left side of the canyon will be operated when the reservoir head is 100 ft. or less while for higher heads discharge will be through two 72-in. steel pipes, one above the other, located in the buttress to the left of the slide gates and equipped with 66-in. needle valves at their lower ends. The 6 x 7½-ft. slide gates discharge into a paved channel between the buttresses which picks up the needle valve discharge below the dam. The lower needle valve is 23 ft. above the top of the slide gates while the top valve is 15 ft. above the lower one.

Because Bartlett Dam was the largest of its type, preliminary studies, model tests and structural analysis, were all carried out with extra thoroughness. Buttress stresses were calculated for loadings such as moment, thrust, and shear forces from the arch barrel, direct water load, temperature variations from water to air exposure, and earthquake shock. Rotations due to moments and thrusts induced by the arch barrel were checked by interferometer analysis and optical measurements of loaded bakelite models. The stress analysis of the arch barrel included the effects of elastic deformation due to shear, rib shortening, yielding abutments, earthquake shocks, and overtopping water loads. Beam action as well as arch action was investigated.

The net result of the design study was to show that the stresses from temperature change are considerably greater than those from water loads. Since the reservoir will contain water for only about three months of the year, temperature changes during the balance of the year are bound to be severe.

For the buttresses, a concrete unit stress of 600 lb. per sq. in. and a sliding factor of 0.7 were used in the design. For the arches, different steel and concrete unit stresses were used for full and empty reservoir conditions, namely, 650 lb. per sq. in. for the concrete and 10,000 lb. for the steel under full reservoir and 750 lb. per sq. in. for the concrete and 20,000 lb. for the steel when the reservoir is empty.

Principal buttress reinforcing steel is concentrated in the upstream face slab and in the side walls. In the latter, vertical bars and inclined bars parallel to the upstream edge of the buttress are placed near the outer surfaces to resist temperature stresses. The inclined bars are lapped in the vertical contraction joints, or slots, which were the subject of much study. As finally designed, these slots are 18 in. wide and spaced 41½ ft. on centers. The sides of the joints are in sawtooth steps 5 ft. apart vertically, the slope of the steps being normal to the average resultant forces acting between the buttress units.

In the arches, circumferential bars

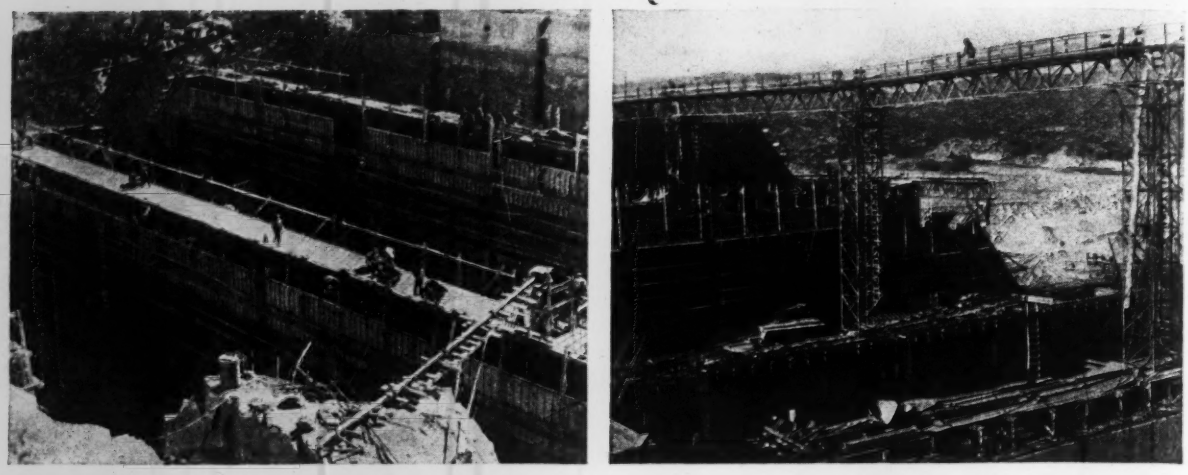


Fig. 4. Buttress concrete (left) placed by buggies operating on platform which is raised with inside forms. Concrete pipeline from mixer is laid on ground at the left while the high-level pipeline bridge for a later stage of the work is shown at the right.

are spaced 8 in. apart throughout the length of the barrel and lapped 50 diameters at the splices which occur at the one-eighth points adjacent to both crown and abutments. (Fig. 5). The steel in the abutment sections of the arches is extended a minimum of 50 diameters into the buttresses, thus eliminating the necessity for locating a splice at the junction of arch and abutment. Longitudinal spacer bars in the arches are 12 in. apart up to the one-eighth points adjacent to the abutments and 24 in. apart elsewhere.

The dam site

The site available for this notable dam is unusually good, consisting of a canyon only about 275 ft. wide at the bottom, about half of which is occupied by the river, and with fairly steep wall slopes that flatten out near the top. An ideal foundation is provided by a fine-grained granite covered with about 70 ft. of fill in the river channel, but exposed on the abutment. An old fault crosses the canyon at the site but it is at most 3 ft. wide and readily plugged with concrete. Geologists are agreed that the region is not now subject to earthquakes, and a large balanced boulder just below the dam provides visual evidence of a long period of seismic inactivity.

The construction plan

At the beginning of the work a construction plan was adopted which has since been followed with only minor departures. As stage 1, an earth dike down the center of the canyon confined the stream near the right bank while the two buttresses on either side of the permanent outlet channel at the left of the dam were built as shown in the top view of Fig. 3. The river was then diverted between these buttresses into this outlet channel, utilizing an upstream timber cofferdam connecting one of the buttresses to a nearby rock island. Downstream, the permanent training wall of the outlet channel carries the water beyond the construction site. With the river thus diverted the deep excavation in the center and at the right bank of the canyon could be completed, and this part of the dam built.

This plan has worked well despite several unusual floods. The first of these, early in February, 1937, brought a record discharge of 90,000 sec.-ft. into the deep excavation, and was followed by two of 30,000 sec.-ft. discharge each, later in the month and early in March. The hole had to be pumped and cleaned out after each flood but little delay of schedule resulted. The following July, while the contractor was carrying the summer flow of 200 sec.-ft. through a 6-ft. diameter pipe laid in the outlet channel and while the buttresses on either side of this channel were only part way up, a flow of 375 sec.-ft. washed out the pipe and did slight damage. Finally, in March, 1938, the river did the unexpected and discharged 92,700 sec.-ft. past the dam, washing out the cofferdams and burying the concrete mixer and a dragline but doing no damage to the structure, although work was delayed about two weeks.

At present about one-half of the concrete yardage in the dam is placed, the buttresses are above high water level (about 170 ft. above deepest foundation), and all arches are built up to low-water level. Work this summer is concentrated on building the odd numbered arches to the top, and it is contemplated that between October, 1938, and April, 1939, the even numbered arches will be completed. In the arch over the outlet channel, which incorporates the slide gates, an opening will be left in the bottom to pass the streamflow until the remainder of the dam is completed.

The contractor's plant

To carry out the construction plan the contractor assembled a plant consisting of shovels and draglines for excavation, trucks for haulage, a screening plant for aggregate processing, a central plant for concrete mixing, pumps, buggies and buckets for concrete transportation, and a fixed-tower cableway of 1,140-ft. span for handling forms. The only change of note in this equipment list has been the addition of up and downstream overhead cables for drifting the cableway hook. Originally this drifting was done by a line from a tractor hoist on the cofferdam, but this procedure proved unsatisfactory and slow.

Excavation was a simple and straightforward operation, the ma-

terial being wasted in up and downstream cofferdams. Because of diagonal jointing, however, the rock broke badly and quantities ran considerably above estimates. For the dam, 190,000 cu. yd. of common and 125,000 cu. yd. of rock excavation were removed, while the spillway cut accounted for another 100,000 yd. of rock and 10,000 yd. of common excavation. After reaching bedrock, trenches about 10 ft. deep were cut for the buttress footings and for the arch cut-offs, and the foundations were ready for concrete.

Concreting

It is in the concreting that principal interest in Bartlett Dam construction lies, for concrete of high quality is required, it is being placed by pumpline, which is uncommon on dam work, and the forms required are special and relatively intricate. Low-heat cement is used to reduce cracking to a minimum, and all concrete is vibrated to insure compaction and proper placement around the reinforcing of which there is 2,900 tons in the dam. Concrete yardage is small—85,500 in the buttresses and 35,000 in the arches—and it is being placed at a rate of 12,000 yd. per month or at an average of 400 yd. per 24 hr., although daily placements approaching 1,000 yd. have been made.

Aggregate is obtained from a deposit in the river about a mile below the dam site at which location a screening plant has been set up. The maximum size aggregate specified is 3 in. except in the gravity section abutments where 3 x6-in. cobbles are permitted. Since the yardage utilizing these cobbles is relatively small, the contractor elected to use the 3-in. maximum size for all of his concrete, and as a result the three sizes turned out by the plant are 3/16 to ¾ in., ¾ to 1½ in., and 1½ in. to 3 in. Since the bank-run material is deficient in fines, a blending sand is added to the gravel as it enters the screening plant. The amount has varied from 15 to 30 per cent of the total sand required, depending upon the operator's visual judgment as to the necessary fineness modulus. Check tests have shown that this unusual method of determining fineness modulus is surprisingly accurate. The screening plant material is stored over a tunnel consisting of old forms used by the contractor in lining conduit sections of the Colorado River aqueduct and large enough to permit trucks to be driven into it and loaded from chutes.

The aggregates are trucked to the batching and mixing plant on the right bank of the river just below the dam, where they are dumped into timber bunkers that feed weighing batchers which in turn discharge onto a conveyor belt leading to the mixer. Sand is placed on the belt first followed by the next larger size aggregate, and so on. This method of piling in layers aids the mixing operation. Cement (trucked 54 miles from Phoenix) is added last, from a 2,000-barrel silo. Mixing water for the 2-yd. tilting mixer is taken from the river.

Concrete transport is, as stated, largely by pumpline, an exception being the placing of the foundations and lower parts of the buttresses in the deep excavation from buckets hauled from the mixer in trucks and lifted into the forms by a crane. The two-cylinder 8-in. concrete pump was located on the canyon floor directly below the mixer until recently, when it was removed to a position high on the right abutment where it is fed from buckets handled from the mixer by an inclined cableway, as shown in the lower view of Fig. 3. In the latter position the pump has only a slight lift to overcome to reach the top of the dam.

In the early stages of the work the concrete line for the buttresses across the river was carried on a suspension

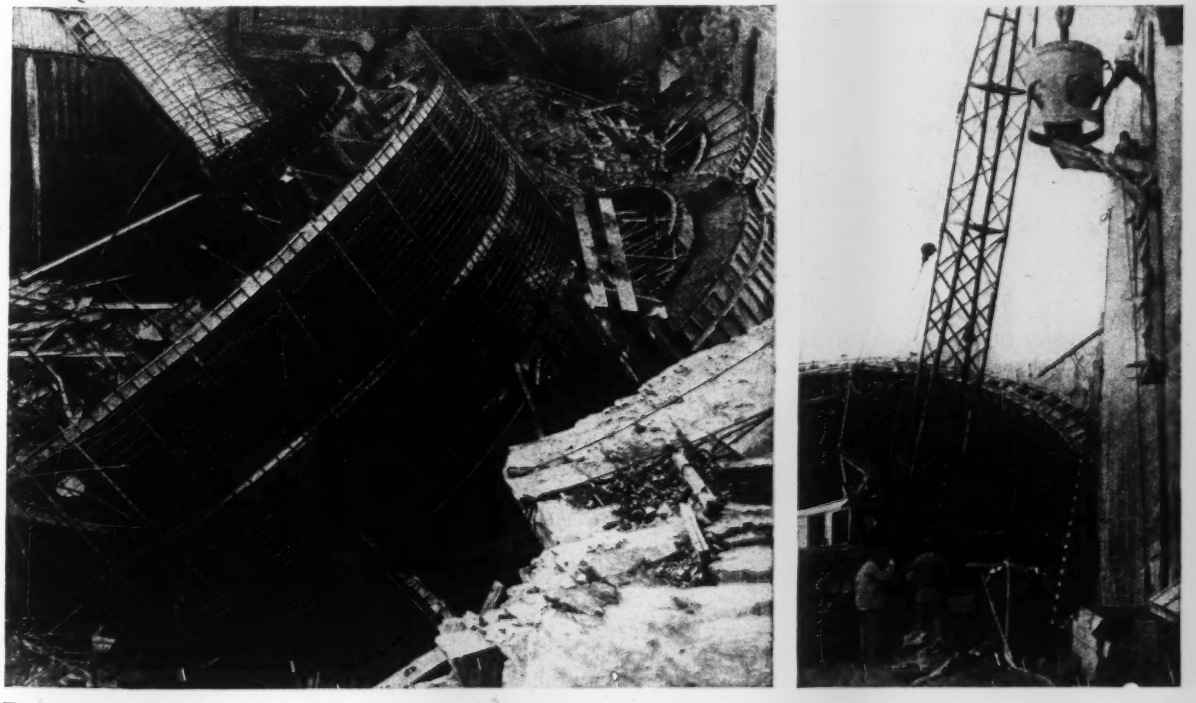


Fig. 5. **Arch forms and reinforcing for Bartlett Dam. View at right also shows procedure used to concrete the contraction joints in the buttresses.**

bridge, while the line for the buttresses on the near side was merely laid on the ground and carried up into the forms on wooden falsework. Under these conditions, the maximum length of pipe was 785 ft. and the maximum lift 45 ft. in a line containing a half-dozen bends. When lifts greater than this were required, the pump was transferred to the higher elevation, as stated, and a steel construction bridge (Fig. 4, right) was built across the top of the dam to carry the pipe-line. This bridge is built at a high enough elevation to permit placing four 10-ft. lifts of the buttresses and will then be raised another 40 ft. It is supported at each buttress by a 6 x 6-ft. steel tower carried on shelf angles fastened to the interior faces of the walls. Inside each of these towers is a 2-yd. hopper which can be adjusted to the elevation of the particular pour. Concrete piped over the bridge and down the towers to the hoppers is discharged from them into buggies which transport it to the point of use.

Forms

The forms designed for the work have proved unusually efficient. For the buttresses, which are poured in 10-ft. lifts 40 ft. long between contraction joints, the outside forms are of structural steel and are in one piece. Attached to the forms are three tiers of platforms, 8 ft. apart vertically, which give workmen access to the she-bolts that hold the forms and also to the new concrete surfaces b low the forms. Another feature of these forms is a series of timbers projecting above them to support and align the vertical and diagonal reinforcing bars in the buttress walls. This assembly of forms, platforms and reinforcing supports (shown in the left view of Fig. 4) is raised as a unit by the cableway.

Forms for the interior surfaces of the buttress walls are also of steel, each 40-ft. pour section being made up of three boxes, 10 x 8, 20 x 8 and 10 x 8 ft. in plan, to accommodate the cross-walls. The tops of these interior forms support the working platforms over which the concrete buggies operate. Strips of these platforms at each edge are hinged, so that they may be turned back onto the center of the platforms when the interior forms are being raised by the cableway.

The forms for the arch barrels are also of steel. Since the intrados of the arches has a constant radius of 24 ft., the underside forms are relatively simple. They are carried on trusses which ride on rails attached to the buttress walls parallel to the sloping upstream edge and are raised by hand hoists and block-and-falls. The extrados forms, however, decrease in radius from bottom to top, and after each pour (15 ft. high on the slope and 11 ft. vertical) small filler sections are removed. In raising the extrados forms they are slid along the sloping upstream buttress faces. A block-and-falls connected to clevises bolted to the upstream buttress face is attached to each edge of the forms and an A-frame hoist, set up on the previously poured arch barrel, as shown on the center arch of Fig. 1, is attached at the center.

Because the arch barrels are on a slope it is difficult to fill the crown of the extrados form with concrete. This difficulty has been overcome by casting a lip on a supplementary shelf above the face of the pour at the crown, in other words, filling the form to over-flowing and supporting the overflow by a cantilevered shelf. After the concrete attains its initial set, this lip is knocked off.

Concreting technique with these forms follows usual practice. Horizontal buttress construction joints (the top of each pour) are cut with air and water 5 to 6 hr. after placing or as soon as the concrete has set enough that the aggregate will not wash out. The arch construction joints, one the other hand, are wet sand blasted 12 hr. after each pour. All concrete is cured for three weeks with water from a system of perforated pipes.

The contraction joints in the buttress walls are filled by the method illustrated in Fig. 5, not less than 15 days after the concrete is placed. This time interval is based upon the fact that the temperature rise in the concrete reaches a maximum in 3 days and then falls until it levels off in about 15 days. The total rise is about 35 deg., with the low-heat cement used. In March, for example, concrete poured at 60 deg. rose to 95 deg. in 3 days and had a temperature of 55 deg. at 15 days.

The only other special operation remaining to be described is the grouting of the cutoffs around the upstream edges of the arches and buttresses. The specifications require holes alternately 75 and 100 ft. deep into the foundation rock on 5 ft. centers. To grout these holes without displacing the foundation rock and any concrete that had been placed required the development of a special technique. The procedure used was to grout all holes to 10 ft., then stage grout the 100-ft. holes between 10 and 40 ft., 40 and 70 ft., and finally 70 to 100 ft. After this was completed the 75-ft. holes were grouted from 10 to 75 ft. at a single stage. Pressures varied from 50 lb. per sq. in. for the first 10 ft. below the surface to a maximum of 350 lb. per sq. in. at the 70- to 100-ft. stage. During grouting operations precise levels were taken on rock and concrete in the vicinity. If uplift reached a value of 0.004 ft. grouting pressures were reduced, and if the uplift then continued, grouting was stopped and work transferred to some other hole.

Administration

Bartlett Dam is being built for the Salt River Valley Water Users Association by the U. S. Bureau of Reclamation, John C. Page, commissioner, R. F. Walter, chief engineer; S. O. Harper, assistant chief engineer; J. L. Savage, chief designing engineer, and K. B. Keener, senior engineer in charge of dams. E. C. Koppen is construction engineer for the Bureau on all Salt River project work with offices at Phoenix. On the Bartlett Dam, J. A. Fraps is resident engineer; W. A. Dexheimer, field engineer, and E. S. Huntington, office engineer. The contractor is Barrett & Hilp and Macco Corp., for which C. G. Clapp is superintendent.

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Local Housing Agency Set Up in 27 States

With the creation of a local housing authority in Burlington, Vt., the number of states which have local housing authorities has increased to 27. Legislatures in 33 states have passed low-rent housing legislation enabling their cities to establish local housing authorities. In six of these states no local housing agencies have been set up as yet. They are Oregon, North Dakota, Colorado, Arkansas, Virginia and Rhode Island. The Virginia enabling act became operative June 21.

Closing Sluiceways Under Head

A. B. MacMillan

Vice-President, Aberthaw Company, Boston, Mass.

Steel-beam grill sunk and closed with plank needles reduces flow for placing tight plank gate

A METHOD of closing sluiceways under water head that proved highly successful is illustrated by the accompanying sketch. The method was used in replacing a 200-ft. middle section of a 450-ft. concrete dam breached by the Connecticut flood of 1936. No relief gates existed through the original dam and none was provided in the new work and as the sill of the forebay to the wheels was only 9 ft. below the crest of the dam, it became necessary to pass the entire flow through the repair work.

The dam was rebuilt in three sections, each about 66 ft. long. The first section at one end was enclosed in a cofferdam of steel sheet piling and 5 sluiceways 10 ft. wide by 6 ft. high were left through the new work at completion. This cofferdam was removed and the second section at the opposite end was built with four sluiceways 10 ft. wide by 8 ft. high. The central section was next completed, the river during this period being diverted through the sluiceways in Sections 1 and 2.

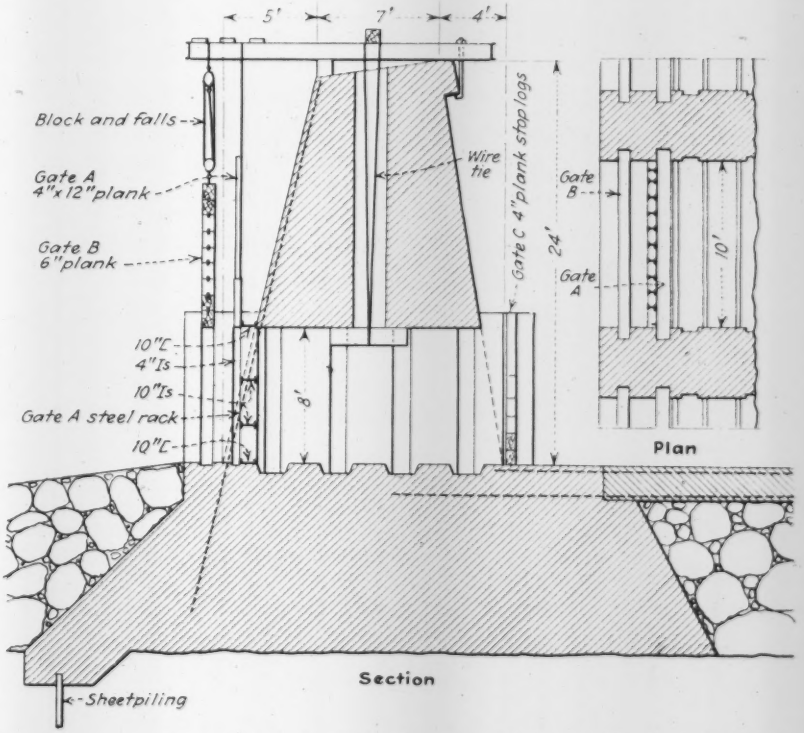
It now became necessary to close the sluiceways. The five in the first section offered no difficulty. By means of a large derrick which was mounted on the crest of the dam, ordinary built-up gates were installed, the derrick was removed, and the sluiceways were filled with concrete. This diverted the entire river through the remaining four sluiceways and the flow was sufficient so that at times the water level was 3 ft. above the top of the openings.

It seemed evident that any attempt to lower solid gates into place was bound to meet with difficulty so that the following scheme was devised: As shown, three gates were provided at each sluiceway. Gate *A* consisted of a steel framework made of 10-in. I-beams and channels placed horizontally and 4-in. I-beams placed vertically. The spacing of the 4-in. I-beams was such that a piece of 2x4-in. timber could be driven between the outside beams and the concrete buttresses, and a 4x12-in. plank could be placed snugly in each of the spaces between the intermediate 4-in. I-beams. This framework was lowered into place in the slots in the sluiceway and the planks were set between the I-beams, lowered down so that the bottom edge of the timbers were flush with the top of the sluice, and held in this position by wires to the working platform of the dam. Gates *B* were ordinary built up gates of 6-in. plank. They were entered in slots and held by blocks and tackles. Gates *C* on the downstream side were simply 4-in. plank stop-logs to retain concrete when the sluiceways were filled and were set in place as concreting proceeded.

When everything was ready two men were stationed at each of the four sluiceways. At a signal the wires holding the 4-in. plank were cut and the plank were quickly driven into place using a piece of 3x4-in. timber to ram them down. This stopped the flow of the river almost entirely. Gates *B* were then lowered without difficulty, there being little or no pressure against them. The spaces between gates *A* and *B* were filled with concrete and inspection of the downstream side of gate *A* showed that all leakage was stopped.

The above operations took less than an hour to complete. The working platform was next removed and simultaneously the operation of filling the sluiceway openings started. Concrete was poured through circular openings from the crest of the dam to the top of the sluiceway. Stop logs were added progressively.

When the last concrete was poured timbers were placed on top of the buttresses from gate *C* to the back of the spillway to prevent possible scouring of the new concrete and 1 hr. later or 12 hr. from the time the final closing was started the pond had filled and was overflowing.



Ingenious gate arrangement designed in advance made the closing of dam sluiceways under head a simple operation.

FIG. 1. PULVERIZING WITH A DISK HARROW WHICH DOES NOT DISPLACE SOIL LONGITUDINALLY OR TRANSVERSELY

How To Process Soil-Cement Roads

FRANK T. SHEETS AND MILES D. CATTON

President, Portland Cement Association, Chicago, and Member, Development Department, Portland Cement Association, Chicago

Recommended operations, equipment and field organization based on experience on nearly thirty soil-cement road jobs

Armed with the laboratory information outlined in the previous article, the road engineer has the problem of building a soil-cement road in the field. What are the processes? What equipment is it best to use? What field control tests are required and how are they conducted? What sort of work organization is necessary? The answers to these questions based on field experiences on some 30 operations throughout the United States, are summarized here. —EDITOR

AFTER THE CONSTRUCTION of the Johnsonville, S. C., soil-cement road project, mentioned in the previous article (*ENR*, June 23, p. 869) proved the practicability and economy of the use of soil-cement for light traffic roads, other states built demonstration sections using the existing soil in the roadway. Each job added to construction and cost knowledge. The officials of the Wisconsin Highway Commission made an outstanding contribution to simplification and control of construction by proving the excellent mixing ability of field cultivators, "quack grass diggers," on mixed-in-place construction.

The mixed-in-place construction procedures used on the Johnsonville job have been proved to be basically sound and have been simplified and improved by the 1936 and 1937 experiences. The various recommended mixed-in-place construction steps, which are most economical and practical, can be summarized briefly as follows:

1. Scarify roadway to depth of 5 to 6 in.

2. Pulverize roadway with two 24-in. offset disk harrows. During normal construction weather, the windrowing of pulverized soil provides sufficient rain protection.

3. On short jobs, cement bags may be spotted by hand at predetermined longitudinal and transverse intervals to give the required cement contents and then dumped and spread. A mechanical spreading device with transverse agitator bar may be used on the larger jobs.

4. Mix cement with the pulverized soil for the required width and depth, usually 6 in, with repeated trips of spring tooth field cultivators and occasional trips of offset disk harrows or gang-plows.

5. After a uniform mixture of soil and cement is obtained, add the water required by successive trips of a pressure distributor. Each increment of water is mixed into the soil-cement mixture with repeated trips of the cultivators. Water mixing continues until the moisture content of the moist soil-cement mixture equals that which previous laboratory tests show was required to give maximum density when sheepsfoot rollers are used to compact the mixture.

6. Sheepsfoot rollers are brought on to the section as soon as the required moisture condition has been attained, and pack the mixture from bottom up.

7. As the sheepsfoot rollers pack out, a blade grader shapes the section to required grade and crown. Compaction planes, in or close to the

surface, left by the sheepsfoot roller and blade grader must be scratched out by one or two round trips with a spike tooth harrow.

8. Final surface is obtained with smooth wheel rollers. A tandem roller is preferred. The final rolling irons out high and low spots, loose areas and knits the surface together.

9. The completed surface is covered with damp straw, hay or earth for seven days to prevent large evaporation losses during the early life of the surface.

Figures 1 to 12, inclusive, taken on the Moniteau County, Missouri, project, illustrate these typical steps in construction.

Equipment requirements

Construction procedures are simple and easily followed with a little experience. All the needed equipment will be readily available in many localities with the possible exception of the field cultivators. However, their cost is small and the two required for normal operations cost about $300.

Equipment requirements vary with soil types. A specific analysis should be made of each job to insure minimum equipment charges. The following list of equipment will be adequate for pulverizing a heavy soil and processing 2 000 to 3,500 sq. yd. of 6-in. compacted roadway per 10-hr. day:

1. Subgrade rooter (adjustable scarifier on power grader will reduce equipment needs).
2. 10-ft. offset disk harrows, minimum diameter of disks, 24-in.
1. Box sand spreader with internal agitator or equivalent for spreading cement from dump body trunks.
6. 1½-ton tight dump body trucks or equivalent.
4. 35–40-h.p. track type tractors.
2. 8-ft. spring-tooth heavy duty field cultivators, with teeth back of wheels, power lift and 1¾ to 2-in. double pointed shovels on each outside tooth and 4- to 5-in. shovels on remaining teeth.
1. 1,000-gal. bituminous pressure distributor (for water).
2. 1,000-gal. feeder tanks on trucks, or equivalent. Minimum water requirements on the job should be considered as 100 gal. per min. This will require the 1,000-gal. distributor to be filled and then emptied on the roadway once every 10 min. Water spreading will become slow and expensive unless critical attention is given to the water supply. Some water may be added the previous day.
1. 3-bottom gang-plow (optional).
1. 10-ft. spike-tooth harrow.
1. Power-controlled auto-patrol, 12 ft. blade, tandem drive preferred.
2. Double drum sheepsfoot rollers, type to be dictated by soil conditions. Range of foot pressures to be about: 50 lb. per sq. in. on foot having 10–12 sq. in. of area for very friable soils, and about 150–350 lb. per sq. in. on foot having about 5½ sq. in. of area for heavy clay soils or soils containing appreciable quantities of aggregate.
1. Tandem smooth-wheeled roller, size to be dictated by soil conditions, 3- to 5-ton roller for very friable soils, 8- to 12-ton roller for heavy clay soils or soils containing appreciable quantities of aggregate.

Personnel requirements

The construction force required to operate this equipment economically and the personnel for engineering control of the job can be summarized as follows: For (1) construction, a superintendent, a foreman and a timekeeper; 5 or 6 semi-skilled laborers to operate tractors, blade grader, bituminous distributor, rollers, etc. An experienced, efficient blade-grader operator is essential for final finishing operations and 10 to 15 common laborers to handle cement, etc. and (2) engineering, a project engineer and a soils engineer and assistant.

The soils engineer will require a small portable testing laboratory equipped for running the required moisture and density soil tests during construction. A trailer can be converted into a very efficient and economical field laboratory.

Mechanical mixers

As new road processes are developed, the question of machinery for mass production immediately arises. Present knowledge of requirements for building soil-cement roads and road building equipment now on the market indicates that no difficulties should be encountered in producing a machine which will mix soil, cement and water. However, extensive developments are needed to add attachments which will spread the mixture to a uniform depth and compact it uniformly from the bottom, to maximum density.

While no major mechanical difficulties are anticipated, such machines entail a large investment which at present cannot compete economically with mixed-in-place procedures on the shorter jobs. How-

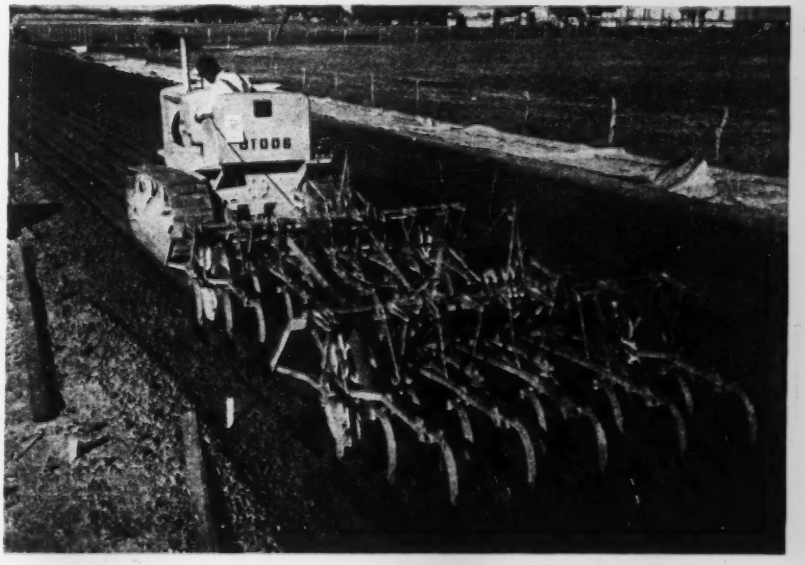


Fig. 2. Mixing soil and cement with field cultivators ("quack grass diggers").

Fig. 3. Paper cover will protect pulversized soil very effectively during the rainy season.

Fig. 4. Spreading cement with garden rakes. Dump trucks and sand spreaders are more efficient.

Fig. 5. Checking depth of treatment with control grade stakes on shoulders.

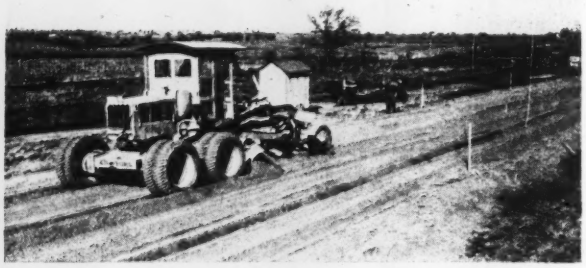


Fig. 6. Shaping up the road section after complete mixing of the soil and cement.

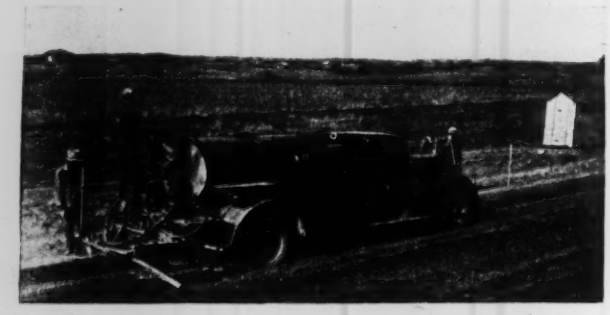


Fig. 7. Adding water to bring soil-cement mixture to optimum moisture content.

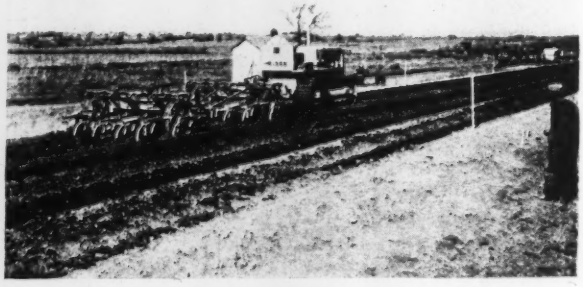


Fig. 8. Mixing water into the soil-cement mixture with field cultivators.

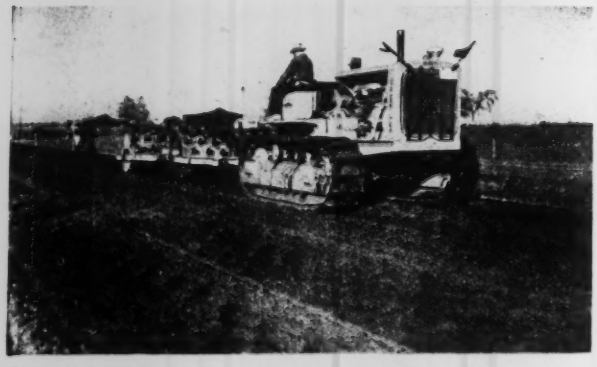


Fig. 9. Packing moistened soil-cement mixture from the bottom to the surface with sheepsfoot rollers.

Fig. 10. Shaping up the top mulch after sheepsfoot rollers have packed the mixture up to the surface.

ever, a machine and auxillary equipment for building this type of road might be compared with a concrete paving layout from a broad economic standpoint. A concrete paving contractor needs 10 to 20 mi. of contracts yearly to cover his overhead. With a similar investment in soil-cement road building equipment he would require contracts for 20 to 40 mi. per year to keep the equipment economically occupied.

TABLE I

State	Number of Projects	Length in Miles
California	3	2.10
Connecticut	1 (Streets)	0.11
Delaware	1	0.19
Illinois	1	1.12
Indiana	1	0.14
Iowa	1	1.64
Massachusetts	2 (Streets)	0.42
Michigan	1	1.27
Missouri	4*	8.52
North Carolina	1	1.01
Pennsylvania	1	1.97
South Carolina	10†	26.34
Wisconsin	1	3.30
13 States	28	48.13

* 1 mile machine mix.
† 18.29 miles machine mix.

Subgrade treatments with cement

The work with soil-cement mixtures has shown also that it is possible to change the characteristics of a soil by adding small amounts of cement. This characteristic of cement when added to soils, is of practical value where it is desired to improve subgrades for pavements. One specific application has been made to a heavy A-7 soil in Kansas which had very high volume changes. When a concrete pavement was placed on soil of this type there was pavement distortion due to infiltration of water causing the soil to swell and noticeably raise the slab ends. Work of this character was reported by H. Allen. (*ENR*. Mar. 18 and Sept. 9, 1937.)

Soils from this experimental project were sent to Chicago early in 1936, test procedures set up, treated with cement and volume change characteristics studied. The tests on the soil-cement mixtures were run after the cement was added, the mixture compacted at about optimum moisture and the cement permitted to hydrate for the periods noted after which the soil-cement mixtures were pulverized and physical test constants again determined.

Table II gives the results of tests on the raw soil and soil-cement mixtures and includes computations to show the decrease in swell characteristics of the soil. It should be noted that the addition of 4 per cent cement by weight decreases major volume changes 50 per cent and as effectively as greater amounts of cement. This is an excellent illustration of the use of cement to treat unsatisfactory soils or change their characteristics as subgrade material from undesirable to desirable. While soils treated in this manner still have

TABLE II — TEST RESULTS ON RAW SOIL AND SOIL-CEMENT MIXTURES

	Soil-Cement Mixtures (1) Containing						
	Raw Soil	½% Cement (2)	1% Cement (2)	2% Cement (2)	3% Cement (2)	4% Cement (2)	5% Cement (3)	8% Cement (3)
Liquid limit	54	51	48	46	45	45	45	41
Plastic limit	24	24	24	25	27	28	34	33
Plastic index	30	27	24	21	18	17	11	8
Field moisture equivalent	31	31	31	33	32	31(*)	37(*)	34
Vol. at S.L. / Vol. at F.M.E. x 100	80.2	80.4	83.3	81.8	85.9	95.2	89.6	91.6
Shrinkage limit	17	17	20	20	22	28	29	28
Shrinkage ratio	1.8	1.8	1.8	1.7	1.6	1.5	1.5	1.5
Vol. at S.L. / Vol. at L.L. x 100	60.5	62.5	65.8	69.0	73.2	79.2	80.1	83.6
U.S.B.P.R. soil group	A-7	A-7	A-7	A-7	A-7-5	A-7-5	A-5-7	A-5-7

(1) Cement content based on volumes when compacted at optimum moisture by standard Proctor procedure.
(2) Constants determined on pulverized soil-cement mixture by U.S.B.P.R. standard procedure after cement has hydrated for seven days.
(3) Constants determined on pulverized soil-cement mixture by U.S.B.P.R. standard procedure after cement has hydrated for 43 days.

Fig. 11. All smooth compaction planes must be cut out with spike tooth harrow to permit efficient bonding of top surface.

Fig. 12. Ironing out surface and bonding top mulch with smooth wheel roller.

low load carrying capacity of themselves, since the small cement contents only harden them for a relatively short time, the treated soils will function satisfactorily as subgrades under the superimposed load carrying surface.

In addition to using this new building material for the construction of hardened soil-cement roads, there are many other construction fields where it will have application. It should serve admirably for airport runways or even for treatment of the entire area of an airport. It has advantages for erosion control, in ditches and canal linings, for shoulders and back slopes of highways, for earth dams, levees, building block or rammed earth-cement house construction and similar applications. Each of these uses will require careful laboratory and field investigation to determine desirable and economical cement contents, moisture control, densities and construction procedures. Research is planned in all these uses but no effort is being made to make application of soil-cement mixtures to these uses until after thorough investigations and research have been completed. This preliminary work is absolutely essential to insure success.

Summary

Each soil-cement road job has simplified application of laboratory results in the field with attendant economies in construction. Costs of construction will vary from about 25c. to 40c. per sq. yd., $3,000 to $5,000 per mile of 20-ft. roadway, for a 6-in. depth of treatment. All projects have successfully withstood weathering during from one to three winters and withstood traffic without structural breakage. The surfaces produced are capable of withstanding considerable weathering and traffic but construction technique has not been developed to the point where surface finishing is fool-proof. As a result, after the surface has seasoned and has been used by traffic for a month or six weeks it may be desirable to place a light bituminous covering, consisting of prime, tack and 25 lb. seal coat, to insure proper appearance and riding quality.

The successful performance of all these initial projects demonstrates the practicability of soil-cement roadways for light-traffic use. It is absolutely essential, however, that laboratory soil tests be made prior to construction to determine treatment specifications and that competent engineering supervision of field construction be provided for this new road building material.

Old and New Building Methods

by Robert W. Abbett

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Ancient and modern practices mingle on construction of concrete structure in Paris

Excluding the Exposition, the most important building construction job in Paris during the past summer was the new building for the Faculty of Medicine located on Rue Jacob on the left bank of the Seine. This structure, of reinforced concrete, designed by M. Louis

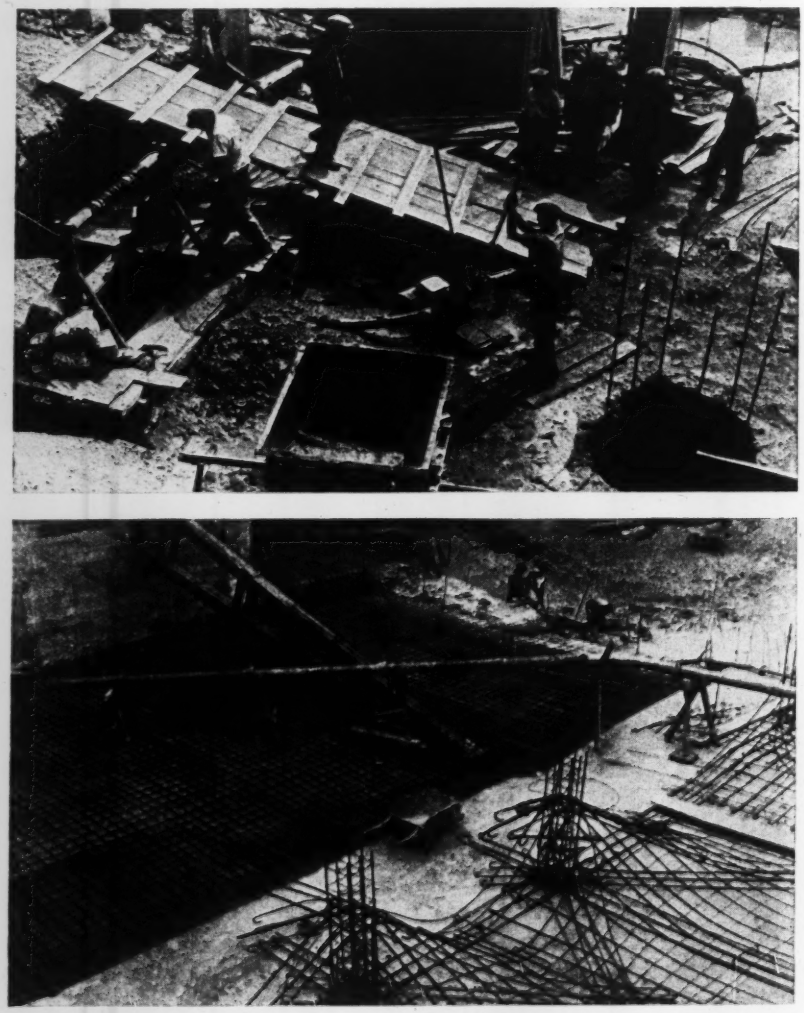


Fig. 1. Ancient and modern construction methods on Paris building. Top—Bucket and windless excavation of a pier and hand pumping. Bottom—Pipeline in place ready for pumping concrete into the foundation.

Madeline, architect, affords an interesting comparison between French and American building construction methods. In it are found a curious intermingling of the most modern labor-saving procedures with old-fashioned hand methods that have been obsolete in America for many years. Under the French law a 40-hr. maximum work week is mandatory, so work was carried on from Mondays through Fridays.

Foundation construction

All excavation was done by hand with pick and shovel. Excavated material was shoveled into wheelbarrows and wheeled to a loading platform in the center of the basement area where it was transferred to steel drums on small narrow-gage flat cars. Each flat car, carrying two drums, was moved by hand to a corner of the building where the drums were hoisted up to grade by a guy derrick and dumped into trucks.

The foundation for one section of the building consists of round piers of reinforced concrete, the excavation for which was also done by hand. Excavated material was shoveled into pails which were hoisted to basement grade by a hand windlass and transferred to narrow-gage cars. The foundation for the remainder of the building consisted of a heavily-reinforced continuous two-way slab. On top of this mat was poured inverted groin vaulting of reinforced concrete to distribute the column loads.

Concrete plant

All concrete was mixed on the job, and the concrete plant compared favorably with the most modern types in America. Mixed concrete was discharged directly into a screw-type pump which forced it through a 6-in. pipeline to the forms. When it was inconvenient to move the pipeline the pump was disconnected, and the mixer discharged directly into small dump cars which were pushed by hand to the desired locations. Concrete was frequently hauled in these small cars to the foot of scaffolds where it was shoveled up through successive lifts, sometimes to heights of three and four floors.

Construction towers were all made of steel and were triangular in plan as distinguished from the American standard square layout; there were no construction elevators on the job. Materials were collected in pails, drums or bundles and were pulled up to the working floors by means of a guy derrick and drum hoist on the top of the triangular tower. Evidently the triangular towers were used only as supports for the derrick and hoists. All scaffolding was supported on cut poles about 4 in. in diameter to which pole cross pieces were lashed and held in position by ropes. As far as could be determined, no spikes were used.

French construction is characterized by high-strength concrete, and this is naturally accompanied by more reinforcing steel than we are accustomed to seeing. Floor forms are somewhat in accordance with our standards, but in the case of larger beams it is necessary to wire the reinforcing steel in place and later built forms around it.

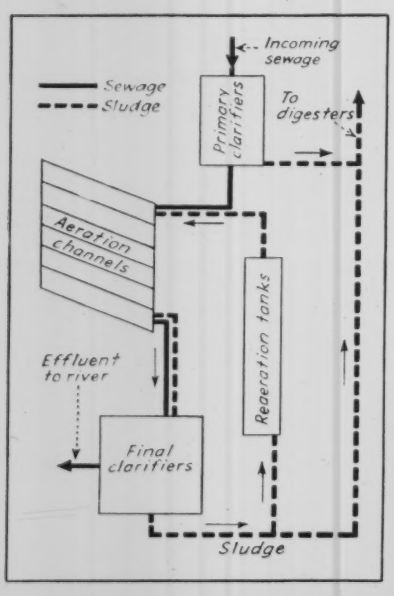
Architecturally the new medical building is modern in design, but the architect has succeeded in harmonizing its appearance with the structures which surround it, notably the Ecole des Beaux Arts and the medieval Cathedral of Saint Germain des Pres.

Fig. 2. Reinforcing steel for a heavy girder is set first, then forms are built around the steel. The lashed pole scaffolding is distinctly a European practice.

A New English Development In Activated Sludge Treatment

Stabilization instead of complete purification will be effected in plant employing double-deck aeration channels more than mile in length

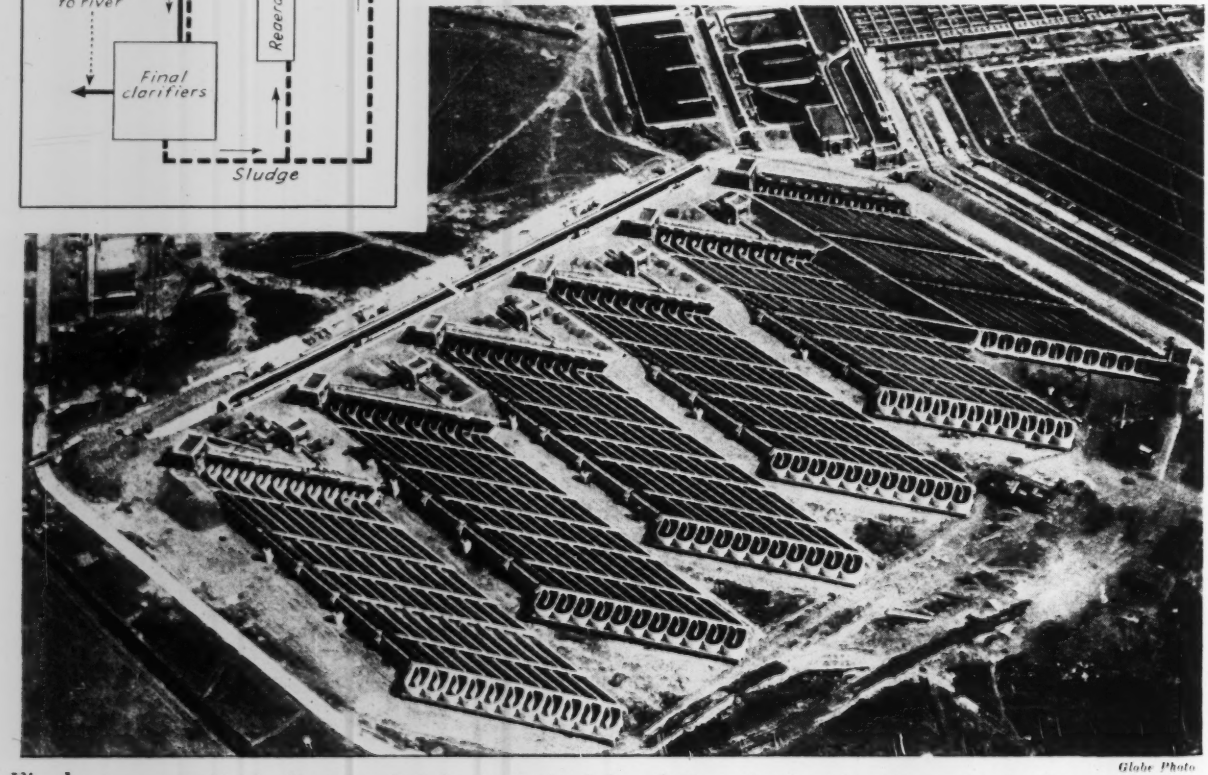
AN UNUSUAL activated sludge type of sewage treatment plant using double-deck aeration tanks is being completed by London County Council at Barking, England. The sewage, inoculated with activated sludge, is circulated by means of paddles through 66 two-tier channels which provide a total flow length of 6,400 ft. (Fig. 1). The plant was designed to produce a stabilized (not highly nitrified) rather than a completely purified effluent. It has a capacity of 66 m.g.d.



The plant operates in this fashion: Settled sewage (containing about 150 p.p.m. suspended solids), is passed to a weir chamber where it is mixed with about ten per cent of reaerated activated sludge. This mixture then flows to the double compartment aeration channels which are 6 ft. wide and 5 ft. deep. There are six aeration units, each with 11 channels, and the liquid is passed alternately through upper and lower compartments until it has traversed all of the 66 channels. The capacity of the channels is 186,000 cu.ft.

A small portion of the liquid is returned from the sixty-sixth to the first compartment, but the main volume is directed to the final sludge settling tanks. There are six of these arranged in parallel; three are pyramidal in shape, some 54 ft. square and 29 ft. deep, and the remaining three are 50 ft. square and 9 ft. deep. The effluent from these tanks is discharged into the river.

Part of the sludge is pumped to reaeration channels where it is reconditioned by air blown through diffuser tiles. Excess sludge, along with that from the primary clarifiers, is digested. The reaeration channels, four in number, are 15 ft. deep and 300 ft. long; they are provided with longitudinal rows of diffusers. The reason for intensive reaeration of the sludge is based upon experimental findings, which revealed that there is an immediate oxygen absorption effect when the sludge is mixed with sewage.



Globe Photo

Fig. 1. Sewage combined with activated sludge is circulated through 66 two-tier channels at the new London County treatment plant. (Insert) Flow diagram of the plant showing the principal units.

Stabilizing Earth Fills with Rock

E. W. VAUGHAN

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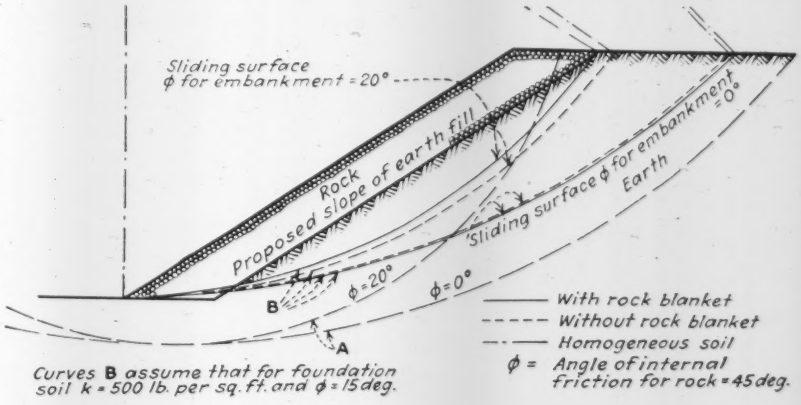
A study of rock blankets for holding fill slopes steeper than the natural slope of the earth in the fill is made for Guntersville reservoir area

In fill construction engineers are often faced with the problem of insufficient earth borrow within reasonable hauling distance for the size of embankment required. It sometimes happens, however, that earth and rock exist within easy reach and in sufficient quantity for fill work if the two materials are used to the best advantage. An instance of this kind occurred in the relocation of highways by the Tennessee Valley Authority in the Guntersville Reservoir area in northern Alabama. The amount of earth available for fill construction was sufficient for a fill 30 ft. high with slopes of 1 on 1½ but the material was found to be unstable at this slope. This necessitated either going a considerable distance for more earth, or using a relatively small amount of rock, which had to be excavated anyway, in stabilizing the fill.

It was suggested that an earth fill with slopes of 1 on 1½ be made and blanketed with a 6-ft. layer of rock. The proponents of this suggestion reasoned that the higher frictional resistance of the rock could be depended upon to strengthen the embankment and preclude the possibility of a sliding failure. A study was therefore made to determine the efficiency of this treatment.


Sliding surface
ϕ for embankment = 20°
Proposed slope of earth fill
Rock
Sliding surface ϕ for embankment = 0°
Earth
B
A
ϕ=20°
ϕ=0°
With rock blanket
Without rock blanket
Homogeneous soil
ϕ = Angle of internal friction for rock = 45 deg.
Curves B assume that for foundation soil k = 500 lb. per sq. ft. and ϕ = 15 deg.

Effect of rock on slide slope of soils for various fractional resistances

Plan of study

The analysis used in determining the stability of the slopes was that generally known as the Swedish method. It assumes that sliding occurs along a cylindrical surface; that the weight of earth above this surface produces sliding, and that sliding is resisted by friction and cohesion acting along the cylindrical surface. The problem consists of determining that surface along which the cohesion required to prevent sliding is a maximum for any given angle of internal friction. For each angle of friction a different cylindrical surface represents the most dangerous condition. This method will not be presented in detail as it can readily be found elsewhere. (Terzaghi, K.- "The Mechanics of Shear Failures on Clay Slopes and the Creep of Retaining Walls," *Public Roads*, December, 1929).

In the determination of the effect of a rock blanket in stabilizing an earth fill two general cases were investigated. The first considered the earth in the foundation and the embankment, with the exception of the rock blanket, to have the same friction and cohesion, and to act as a homogeneous mass. The second assumed that the foundation had a higher shearing strength than the embankment. In the second case the surface of failure may or may not pass through the foundation depending upon whether or not the foundation is little or much stronger than the embankment.

For the case of a homogeneous material, the curve of failure was found to pass through the fill and foundation, extending into the latter about 5 ft. as shown by curves *A* on the accompanying chart. This failure surface passes well below the ground surface at the toe of the fill and does not penetrate the rock blanket. In this case, therefore, the rock contributes nothing to the stability of the fill. The cohesion in the earth required to maintain stability of the fill is shown in the first line of the accompanying table for soils of various frictional resistance.

An example of the failure surface in the case of a strong foundation is illustrated by the curves *B*. In this particular case the foundation was assumed to have a cohesion of 500 lb. per sq.ft. and an angle of internal friction of 15 deg. For these values the surface of failure is maintained within the fill. Thus the entire resistance to sliding is furnished by the fill material itself and its rock blanket, if one exists. The values of cohesion required to maintain stability for various angles of friction of fill material are shown in the second and third lines of the table for an earth fill both with an without rock blanket. The angle of internal friction of the rock was assumed to be 45 deg.

EFFECT OF A 6-FT. ROCK BLANKET ON STABILITY OF A FILL 30 FT. HIGH WITH SLOPES OF 1 ON 1½

Type of Failure	Cohesion of Fill Material Required Lb. per Sq. Ft.		
	Ø = 0 deg.	Ø = 10 deg.	Ø = 20 deg.
Homogeneous soil, A	550	323	127
Strong foundation, no rock blanket, B *	483	309	156
Strong foundation with rock blanket, B *	475	280	110

* For foundations: coehsion = 500 lb. per sq. ft.; Ø (angle of internal friction) = 15 deg. for earth and 45 deg. for rock.

A study of the table indicates that, when the foundation is composed of material for which the cohesion is 500 lb. per sq.ft. and the angle of internal friction is 15 deg., a rock blanket increases the stability of the fill. For such a condition the surface of failure is maintained within the fill. Apparently the surface of failure is forced to go through the rock blanket and thus the increased frictional resistance of the rock is utilized. This apparent increase in stability due to the rock blanket is misleading. It will be noted that curves B traverse the rock dangerously close to the boundary between the rock and the foundation. If the resistance to shear along this boundary is less than the resistance through the rock, the failure surface will surely follow the path between the rock and the soil. A slight distortion of the lower ends of curves B so that they follow this latter path can occur without materially changing the magnitude of the forces that cause sliding.

While it is difficult to determine the actual value of frictional and cohesive resistance between the rock and the foundation soil, it is quite probable that they will be less than for rock only or soil only. Standing or percolating water might develop a sliding surface along this boundary which would reduce the sliding resistance to a negligible amount. To eliminate the possibility of slippage along the boundary, the rock blanket should be keyed into the foundation soil. The depth to which the key should be carried depends upon the relative strengths of foundation and embankment materials. For the case here illustrated a depth of 4 or 5 ft. should suffice.

For the case of equal strength in foundation and embankment the depth of key must be greater than 5 ft. The sliding curves *A* penetrate the foundation to a depth of 5 ft. Similar curves penetrating to 10 ft. were found to be only slightly less dangerous. It appears then, that for this case the key must be carried at least 10 ft. into the foundation for only a slight increase in stability. It will probably not be practicable to do this in most cases.

Conclusion from study

In summary it appears that, when a fill is built on a foundation of much greater strength than the material in the fill itself, a rock blanket keyed into the foundation to a sufficient depth will increase the stability of the slopes against sliding. This increase is appreciable for soils with fairly high coefficients of friction. On the other hand, when the fill and foundation have equal strengths, a rock blanket will be of no value in increasing stability unless keyed into the foundation for a great depth. The depth of key required in this case would be so costly that such construction would not be feasible.

As a result of this analysis and a comparison of construction costs, it was decided that the Guntersville fill should be designed at slopes which would be stable for the soil used without placing any reliance for added stability on the rock blanket. Rock blankets will be used on those sections of fill which cross reservoir pools but only as riprap protection against wave action and not for stability.

The reader might ask if any consideration were given to other methods of rock placement for added stability. In the case of the Guntersville fill, the rock was needed to act as a protection against wave action so that it necessarily had to be placed on the fill slopes. In cases where rock is not needed on the slopes and can be used for stabilizing purposes only, other methods of placement are possible. For example, the rock might be placed in the center of the fill as a core, allowing the available soil to be laid at flatter slopes without increasing the total earth excavation. Again, the rock might be used as the bottom layer of the fill, thus decreasing the height of earthwork and hence increasing the stability of a given slope. A third possibility indicated by the foregoing analysis is the use of rock at the toe of the slope only and well keyed into the foundation. The analysis shows that it is the rock key rather than the rock along the slope which tends to stabilize the fill. In this last instance the keyed toe acts as a retaining wall.

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Water Accounting Manual Prepared

Because many cities do not have practical accounting methods and procedures in their water departments, adequate financial and related information frequently is not available for fixing proper rates for service, financing of extensions and improvements, eliminating waste, and informing the municipal officials and the public of the utility's financial conditions and operations.

To assist municipalities in improving their accounting procedure the American Water Works Association has cooperated with the Municipal Finance Officers Association in the preparation of a "Manual of Water Works Accounting." The manual has been completed and will be published early in the fall.

"The new accounting manual will be the first published work of its kind," said Jacob Schwartz, chairman of the A.W.W.A. finance and accounting division, "and will provide proper accounting guidance to enable introduction of sound business principles in a municipal water department, be it large or small.

"Large investments are made by our cities in water plants and it is highly desirable that they be self-supporting enterprises. The accounts of the water department should be separated from those for other municipal departments, and arrangements should be made to compensate the water department for water delivered to other departments. Otherwise, the cost of supplying water service to consumers appears higher than it actually is.

"The manual will serve in the dual capacity of a yardstick to measure the efficiency of a municipal water department's present accounting procedure and as a useful tool to aid in introducing accounting improvements and refinements where necessary," concluded Mr. Schwartz.

For Designers From an Operator

The superintendent of a modern water purification plant outlines further design refinements

After operating the Wilmette (Ill.) 6-m.g.d. filtration plant for five years W. M. Olson, superintendent, draws on his experience and presents points on design from the operator's viewpoint he feels that designers should include in their plans. Mr. Olson outlined his views to the Peoria meeting of the Illinois Society of Engineers Jan. 28. From his paper the following extracts of major points have been made.

EDITOR.

AN INTAKE free from ice trouble is surely a great blessing. Judging by the success of the Wilmette installation it is now possible to design such an intake for comparable conditions. A description and photograph of the successful structure were presented in *Engineering News-Record* for May 31, 1934, p. 694. (Velocities at 18-m.g.d. capacity through wood racks is 0.10 ft. per sec.).

The chemical storeroom should have a tight roof. It should be partitioned off to provide a dust-tight cell for carbon if powdered activated carbon is to be stored. If the room is in a cold location it should be provided with enough heating facilities to insure against condensation on interior surfaces.

Chemical feeding

The feeding of chemicals is a fit subject for a textbook (which we are not writing). If anhydrous ammonia, chlorine, powdered carbon and granulated alum are being fed they each might well have separate rooms for feeding equipment. Weighing devices should be provided for all machines to give amounts used and also furnish a check on rate of feed.

The use of anhydrous ammonia is desirable because of its convenience. Solution-feed chlorine machines must be provided with a warm water supply if the tap water temperature falls below 50 deg. Fahr. (the temperature just below which chlorine-hydrate forms).

Cylinders of ammonia and of chlorine connected to control apparatus should be clamped to weighing scales with their platforms flush with the floor. In some cases it may be convenient to locate scales and cylinders on a floor below the control apparatus in which cases it is essential that all tubing conveying gases be laid out to drain back completely to the cylinders in service. It is always desirable to maintain a lower temperature about the cylinders than at the control apparatus. Rooms to house apparatus for the control of gaseous ammonia or chlorine should be unheated interior rooms, without windows, but with ample controllable ventilation (either natural or artificial) plus additional forced ventilation available for use in emergencies.

Dry chemicals

In case of chemicals fed dry, care should be taken to provide easy means for charging hoppers. In the feeding of carbon, ample machine and hopper capacity together with a wide range of feed is the first consideration. Freedom from dust is of next importance. Extreme accuracy of feed is probably not worth the payment of any considerable premium to obtain it. In the first place, the more accurate feeders undertake to feed by weight, but in the case of carbon this weight includes a moisture content which fluctuates within wide limits. Likewise the carbon requirement of natural waters fluctuates so rapidly that it is hopeless for the laboratory to expect to follow it with any amount of precision.

Our experience with mechanical mixing indicates that two hours is not too long. In connection with mixing, attention should be given to the economy of combined mixing and aeration with diffused air. If the operating cost for odor reduction by aeration is say one-tenth that for carbon, per unit of odor removed, it is worth consideration as a preliminary to carbon treatment.

Experience proves that something more than a high rate of backwash is required to prevent the formation of mudballs in filters. It does seem, however, that a rise of 42 in. per min. (26 gal. per sq. ft. per min.) tends to limit the maximum size of mudball to that of a walnut and that no further deterioration in quality of bed occurs. (Perhaps this is what we are hoping for at our plant). In order to see what is going on when washing a filter it is desirable that the entire surface of the sand be well illuminated by plenty of lamps properly placed below the filter walks.

Inspection well

When possible the filtered-water collector should discharge into a deep channel to the filtered-water basin. This will provide a strategic location for a sight well and submerged lamp for observing the clarity of the filtered water before its accumulation.

High-lift pumps are almost invariably provided with check valves on the discharge. If these are of the cone or some other type operated by hydraulic pressure, care should be taken that at least two of these valves can be opened by pressure created by the pump to which the valve is attached.

Electrical control

Modern electrical control devices are convenient and reliable and may be used with confidence. Conductors laid in damp locations should be lead covered. Float-controlled pumps should be provided with individual manual-control switches.

In the laboratory, electrical water-heating units should have pilot lamps to indicate when energy is being used. An electrically-heated autoclave should have a large variety of "heats" available.

Some thought should be given to reduction of glare. The use of modern white metals with their resistance to staining and corrosion

cannot be praised too highly for door handles, railings, but their use can be overdone with resulting discomfort to all persons sensitive to light conditions. Only under the most rare conditions is bright white metal a suitable material for use as a frame for a gage or other instrument, or for use on large surfaces such as a door. A dull dark finish would in like cases be much more comfortable to live with.

Suggested locations for emergency lighting are at the operator's desk, at the point where an alternate source of power can be made available, at chlorine and ammonia machines and in front of filter operating tables.

Duplicate plants

Duplicate heating plants should be given consideration. A waterworks handling 32 deg. Fahr. water is in a bad spot in zero weather if anything happens to its only heating unit.

The appearance of the works may be improved by taking thought to the painting of various surfaces. Items desired to be inconspicuous, such as window-guard or unnecessary details tending to show through window glass, should be painted black. Aluminum paint looks well under water in conjunction with unpainted concrete. To reflect maximum light in dark places a glossy white surface is suitable for the water works.

Operating booth

The original design should provide a centrally located operating booth at which controls, meters and gages should be concentrated. The booth should be well heated, lighted and ventilated and provided with suitable desk, chair, blank chart storage space and telephone. Gages should include a recorder of the water level on the filters and in the wash water tank in addition to others more commonly provided. Recording water pressure gages located well below the hydraulic gradient should be of the old fashioned Bourdon tube type. Wherever possible, as in intake or clear wells, glass piezometer tubes should be used to indicate water levels. Overflows should be provided to protect against flooding.

New Flood-Control Act Extends Federal Authority

R. B. GARRABRANT

Washington Correspondent, *Engineering News-Record*

New act gives federal government power to build reservoirs without consent of local authorities

PASSAGE of the 1938 flood-control act gives the United States government, for the first time, the authority to build and operate any flood control dam and reservoir it deems necessary regardless of the approval or dissent of the local authorities and, if necessary, to condemn the necessary land. By clear implication it also confirms title in the United States to any incidental power that may be developed.

This extension of federal authority has been attacked, both in Congress and outside, as an unconstitutional invasion of rights reserved to the states. It is defended by the Administration as a necessary and proper assumption by the central government of latent powers hitherto not exercised but always implied in the federal authority over interstate commerce. Until a test case can be brought before the Supreme Court the correctness of this claim can be but a matter of opinion. However, a comparative discussion of the two points of view should be of interest.

Case for opposition

The case for the opposition can be stated briefly. It is based on the Tenth Amendment, which reads: "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." Nowhere in the Constitution is there mention of flood control; therefore it is neither a power granted to the United States, nor a power prohibited to the states. Consequently, only the states have authority to build flood control reservoirs, and any participation by the federal government must be with their acquiescence.

The argument for the federal government is far more complex, and depends for its effect upon historical perspective. In condensed, and perhaps oversimplified, form it is this: The Constitution provides specifically that "The Congress shall have power . . . to regulate commerce with foreign nations, and among the several States . . ." Under the doctrine of implied powers this has been expanded, from time to time, to permit the federal establishment to (a) construct navigation aids; (b) regulate the construction by others of structures that might obstruct actual navigation; (c) extend this regulation to non-navigable reaches of a stream where the structures might affect navigation further downstream; (d) construct such structures in order to improve navigable conditions below.

The term "navigation" itself is broadly construed, and its legal meaning has been held to contain much more than is implied by the popular mental picture of a steamboat on a river. To the courts a navigable stream is one that is susceptible of being used in its natural condition as a highway of commerce.

Additional complication

An additional complication is provided by the practice of using navigation as a Constitutional "peg" upon which to hang other purposes —by no means an invention of the present Administration. Federal participation in levee construction on the lower Mississippi was first justified on the ground of improving navigation. Likewise the construction of Boulder Dam. The Okeechobee levees in Florida are still officially a

"navigation" improvement. Muscle Shoals Dam was built jointly for national defense and navigation. The instances could be multiplied indefinitely. In the main, these expansions of federal activities have been uncontested, but the courts have upheld them in the case of Boulder Dam (contested by the state of Arizona) and Muscle Shoals (now Wilson Dam) in the Ashwander case. So the multi-purpose project has legal standing, although there is still doubt as to whether, in the future, the courts may not possibly draw a line to prevent the abuse of this legal invention.

Older than New Deal

Even the federal assumption of responsibility for flood control antedates the New Deal. While it was not until 1936 that Congress, in that year's flood control authorization bill, formally assumed the burden for the entire country, this was merely a generalization of a policy previously adopted earlier in a number of specific cases, notably on the lower Mississippi in 1928. The tie to the interstate commerce clause was carefully preserved in the 1936 act: "It is hereby recognized that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including . . . the impairing and obstructing of navigation, highways, railroads, and other channels of commerce between the states, constitute a menace to national welfare; that it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the federal government in cooperation with states, their political subdivisions, and localities thereof . . ."

Legal argument

The legal argument for the new policy, therefore, may be summarized as follows: The control of floods is an implied power of the federal government under the interstate commerce clause. It is therefore justified in building dams and reservoirs for this purpose. It has as much right to buy or condemn lands for these structures as it has for any other legal purpose—the construction of a post-office, for example. And if, in controlling floods, a byproduct such as incidental power becomes available, this is the property of the federal government, to be disposed of as it may see fit.

Cost complications

So long as flood control remained a joint federal-state undertaking there was no tendency to dispute the validity of federal expenditures for this purpose. But one major difficulty arose from the provisions of the 1936 act. In dividing costs, the principle was adopted that the federal treasury would pay construction costs on a project, while the state or local government would provide land and flowage rights, and would assume any damages that might result from the construction. The proportion varied with conditions at the site, but normally worked out so that the localities paid less than half of the total expenditure.

The rule worked, and still works, in regard to local protective works, such as flood walls and levees. The local people were willing to contribute to their own protection. It failed miserably, however, in respect to reservoirs, for in only a few cases were people willing to tax themselves, and withdraw their own lands from cultivation, in order to build a reservoir largely for the benefit of inhabitants residing downstream. In reporting the 1938 bill the House flood control committee stated: "It has been generally conceded that unless the local contribution for the construction of reservoirs is very materially modified and unless the United States assumes additional cost respecting reservoirs, additional reservoirs, except in a few areas, will not be constructed." The committee therefore reported a bill providing that in respect to dams and reservoirs only the localities would be reimbursed for 70 per cent of their expenditures for lands, flowage rights and damages, leaving them only 30 per cent of this expense to be met from local revenues. The House passed the bill in this form.

The Senate accepted the 70-30 division, but when the bill was reported back to the two houses a 100-per cent federal cost assumption respecting dams, reservoirs and channel improvements (for flood control purposes only) had been substituted by the conference committee as had a provision for land purchase or condemnation by the government.

One other important change in policy was injected into the act by the Senate. The 1936 bill placed responsibility for the construction of on-stream protective works with the Corps of Engineers, and for water-retardation measures in the watersheds with the Department of Agriculture. The Senate amendment places one new agency in the picture —the Federal Power Commission. Its powers are advisory only. In the 1936 act there was a provision making it permissible for the Chief of Engineers, at his discretion, to build into flood control dams penstocks and other provisions needed to permit the future development of incidental power. This is now made mandatory when recommended jointly by the Chief of Engineers and by the Federal Power Commission.

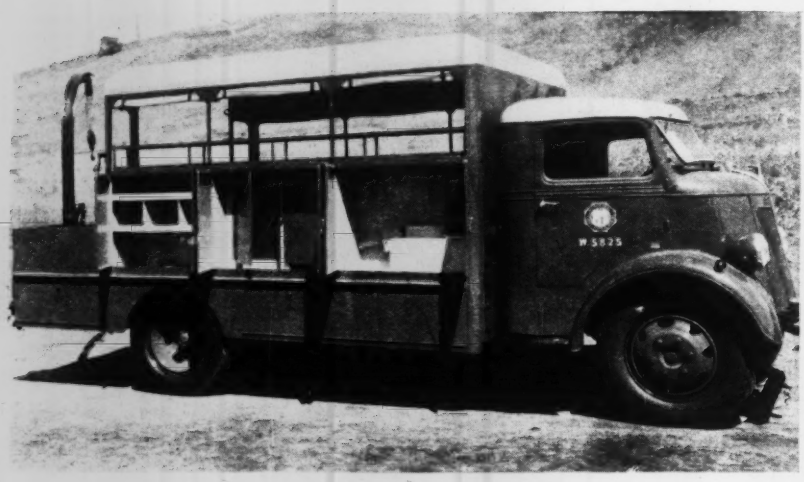
Little power involved

Like any new policy, the decision to make flood control reservoirs a purely federal undertaking has greater importance as a principle than in its immediate practical effect. Of the approximately 100 flood control reservoirs now authorized not more than half a dozen have immediate power possibilities; many will never be suitable for any other purpose than flood storage. Also, every multi-purpose dam yet built or undertaken by the federal government—Boulder, Bonneville, Fort Peck, Grand Coulee, and the TVA system are outstanding examples—is, as a matter of fact, located on land owned in fee simple by the federal government.

As for cramming flood control down the necks of an unwilling populace, the probability is just the reverse. While in theory it is possible for the United States to build a reservoir against the wishes of the local government, in fact the funds available for such construction are far too small to satisfy the demands being made. It is extremely unlikely that the Administration will go out of its way to force a constitutional test of the new law when, as a practical matter, it will be unable for many years to satisfy the demands now being made for reservoir protection from sections that have no intention of questioning the legal justification for such federal expenditures.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill



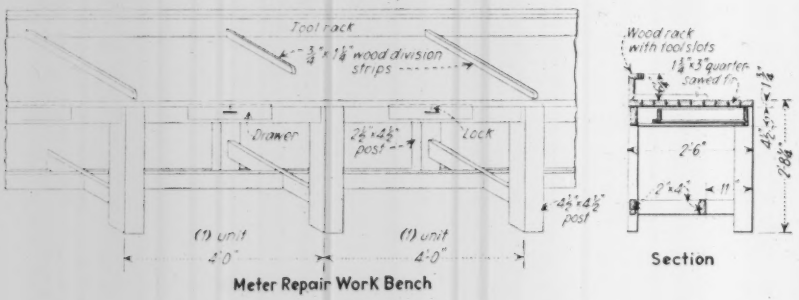
A water department service truck of many uses.

Water Service Truck

Several trucks of the type illustrated have recently been added to the fleet serving the Bureau of Water Works and Supply of Los Angeles, Calif. The truck bodies were designed and built by the general plant division. The illustration shows one of the bodies mounted on a cab-over-engine chassis.

The body is entirely of welded steel; the roof is aluminum painted outside and insulated inside against heat, and the open upper half of the sides may be closed against rain by canvas curtains. All of the frequently used tools are kept in the cabinets on the right, or curb side. Shovels are stored in the boxes below; a pipe vise swings out of the lower rear box and locks in the working position: the left-hand side of the truck has bins for pipe fittings, and a pipe tunnel runs the full length of the body, with open ends for carrying long sections of pipe. A ¾ davit crane is mounted on the rear deck for raising gate valves and other heavy loads to the deck space.

A trench backfiller is also incorporated in this truck. A friction-clutch winch is located behind the cab with controls in the cab operated by the truck driver. The cable from the winch goes through a fair-lead mounted on the front bumper and pulls in the hand scraper.

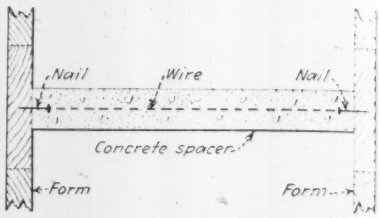


METER TESTING AND REPAIR BENCH

WORK BENCHES have been designed for meter testing and repair operations in the new service building of the Minneapolis Water Department. The bench top is made of quarter sawed fir, reversed, end for end with locked joints. Each man has a 4-ft. unit with individual drawer and tool rack at back. The benches are located against a well-lighted wall.

Simple Form Spacer

Quickly placed and as quickly removed, the form spacer shown by the accompanying sketch is being used by the T. K. Allen Construction Company, a contractor on the All-American Canal. The spreaders are merely small concrete struts about 1



Precast concrete wall-form spacer

in. square reinforced with a single wire and with a nail embedded in each end; they are manufactured in quantity on the job. When one side of a form for a wall is set up, these spreaders are stuck into it by hand; when the other side of the form is erected it is hammered against the spreaders until the nails take hold.

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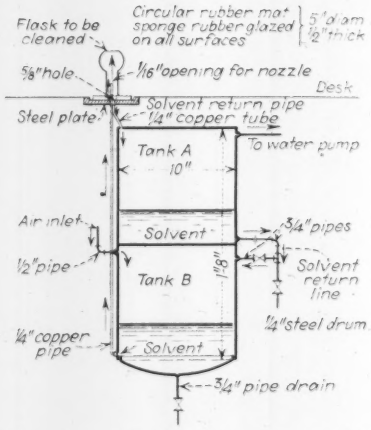


Oil and asphalt flasks are automatically cleaned by this apparatus.

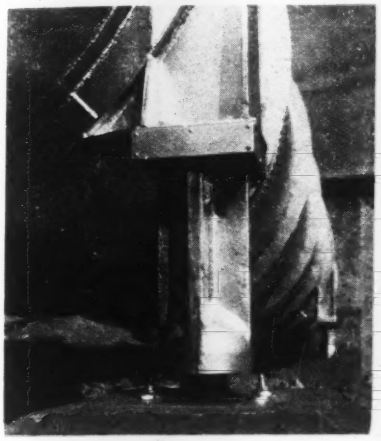
Flask Cleaning Made Easy

JOHN SKAG
California Division of Highways, Sacramento, Calif.

The apparatus illustrated has been used to clean glassware for routine oil and asphalt testing, and has proved to be an important time saver for routine testing.

The solvent is introduced into tank *B* at the first filling. By means of a water pump a difference of pressure is established between Tanks *A* and *B*, and the flask or beaker to be cleaned. This difference of pressure

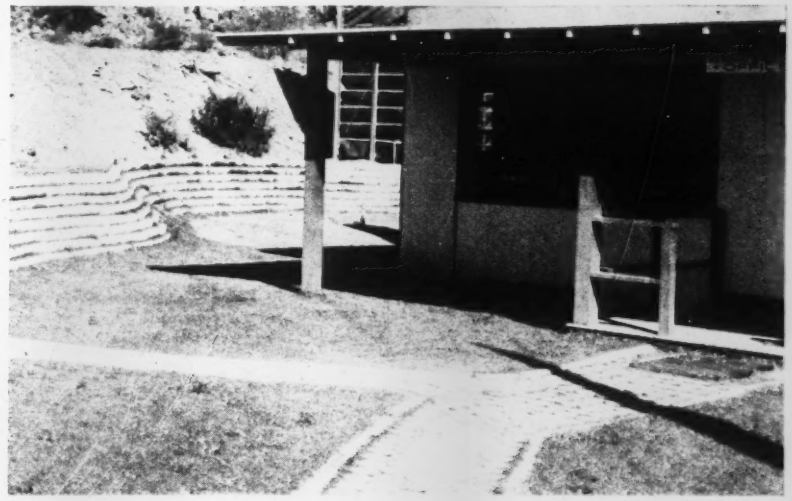
causes a flow of solvent from tank *B* upwards and into the flask and thence back into tank *A*. When all of the solvent has collected in tank *A*, it is returned to tank *B* by a return line. The flask to be cleaned is held against a glazed, sponge rubber mat, as shown in the drawing. The solvent used has been benzol or carbon tetrachloride. The unit is entirely automatic and flasks, such as viscosity flasks are easily cleaned.



CAMERA MEMORANDA

1. Ball and socket supports permit temperature and other movements of the pump-lift line up Iron Mountain on the Colorado River aqueduct. The supporting column on each side is welded to the pipe shell. The ball-and-socket is at the base.

2. Collecting ditches of Denver's transmountain diversion project located at 9,200-foot elevations have to be cleaned of snow which drifts 6-feet deep into them. A crawler tractor dragline is used to clean out the snow so that the full ditch capacity is available to catch runoff.



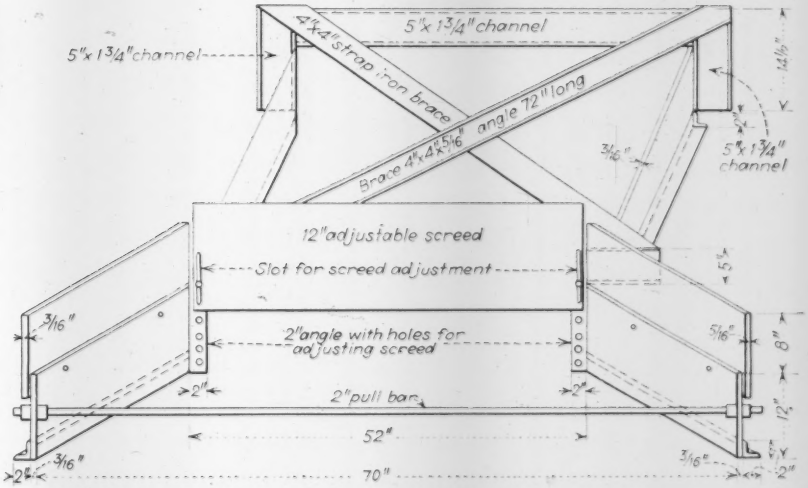
USE FOR TEST CYLINDERS

TEST CYLINDERS for concrete control at Bartlett Dam on the Verde River North of Phoenix, Ariz., are used as they come from the testing machine to build walks and terrace retaining walls. Completely broken cylinders are set endwise in the ground for walks; the cracked cylinders are laid on their sides when used for the retaining walls.

Screed for Placing Measured Windrows

G. S. COVERT, JR.
Assistant Constructon Engineer, Mississippi State Highway Department, Jackson, Miss.

To secure the required thickness of treated mat in road mix construction, fresh aggregate often has to be added to that scarified from the old road surface. In recent operations in Mississippi it has been found fast and accurate to place the new aggregate in windrows of measured cross-section by the screed illustrated. The screed is shown with all the essential dimensions so that it can be constructed by anyone interested. The screed is hitched to an end-dump truck loaded with new aggregate and as the truck moves ahead it is tilted to spill its load gradually between the flared wings of the screed which then spreads it in a windrow of the size required. When one truck is emptied it is unhitched and a loaded truck takes its place. When a crew gets organized the work progresses rapidly.



Screed that deposits road-surfacing aggregate in measured windrows. The truck which drags the screed dumps aggregate into the area shown in the foreground.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

CHEMICAL PRE-TREATMENT—Treatment of sewage containing large amounts of chemical trade wastes by the activated sludge process is considered rather difficult. Use of chemicals as an aid in reducing the load on an activated sludge plant, especially when large quantities of dye and other chemical wastes are present and a high degree of purification is required, is therefore of special interest. Smitz-Landers (*Städtereinigung* 29, 262, 1937) describing the Jung iron-carbon dioxide method of pre-treatment developed in the Niers district, states that such pre-treated sewage can be oxidized biologically by activated sludge in as little as one-half hour aeration time.

The pre-treatment process consists of blowing carbon dioxide through iron scrap (filings) forming iron bicarbonate, and the sewage containing the soluble iron bicarbonate is strongly aerated to remove the excess carbon dioxide and to oxidize the carbonate to ferric hydroxide. The ferric hydroxide coagulates the suspended material in the sewage. Iron scrap is cheap and for the carbon-dioxide supply flue gases or digestion gases are used. The quantity of iron used amounts to only 5 p.p.m.

The pre-treatment process, in removing suspended and some soluble pollutional material, aids the biological treatment, since the detrimental acidic gases are removed by aeration prior to the secondary treatment. The iron retained in the activated sludge is recovered by the simple expedient of storing the sludge. During the storage period acid conditions develop, the pH values drop and the insoluble iron ($Fe(OH)_3$) is reduced to iron hydroxide ($Fe(HCO_3)_2$) which is soluble in carbon dioxide. Mixing of the sludge with the acid pre-treated sewage brings more coagulant in solution and the sludge is settled. In this way the original iron requirement is reduced to 1.5 p.p.m. The leaching of the activated sludge caused a material increase in sludge density. Iron treatment requires 15 min., and the aeration (activated sludge) 30 min.

TRICKLING FILTER—From time to time the purification phenomena taking place in a trickling filter are re-discovered or re-stated. The newer high rate dosages and applications of air have led to fundamental research which permits formulation of some statements of general interest. Assuming that the fundamental action in a trickling filter is similar to activated sludge (except that in the former the sewage passes over the active material and in the latter the active floc is moved through the sewage), the shorter contact time in a sprinkling filter varying from 2 to 4½ hours as compared with 4 to 6 hours in the activated sludge process requires explanation. Pönninger (*Gesundheits Ingenieur*, 61, 34, 1938) believes that the division of sewage into drops which are sprayed over the large surfaces of biological film is of greatest importance for the oxygen intake and subsequent oxidation of the organic material. By overloading or deficient oxygen supply, the reduction processes overbalance the oxidation processes. The higher load increases the contact time required, and this results in clogging and decrease in purification. The decrease in purification is overcome only when the rate of application is reduced.

The passage of air through the filter is not the same through all parts of the bed, so therefore artificial aeration helps oxygen distribution; the higher the rate of sewage application the more important becomes the need for air. The increase in decomposition can be determined by the increased carbon dioxide production. Best results are obtained when the amounts of organic substance to be stabilized are in equilibrium with the biological flora and fauna and in specific relation with the contact time and oxygen supply. These relations can be established by observation during operation. Temporary disruption of the equilibrium can be overcome by varying the air supply, but permanent troubles are avoided only by changing the relationships between food supply, number of organisms and oxygen supply.

OXIDATION COSTS—The cost of oxidizing sewage is affected by the method employed to supply oxygen. The size of the plant or the amount of sewage to be treated is also a factor, because as a rule the smaller the plant the higher the per capita cost and the greater the expenditures per million gallons treated. Frequently cost figures for different types and sizes of plants are available only when treatment works for different municipalities are compared. Of considerable interest, therefore, are the actual construction and operating costs for different types of plants of the same municipality. Comparative data obtained in England (*Jour.* Institution Civil Eng. Nov. 1937) dealing with bioflocculation and trickling filter installations, distinguishes even between fixed spray jets and rectangular travelling distributors. Costs for land, engineering charges, road maintenance, etc. are excluded and all interest on loans are taken as 4¾ per cent.

	Bioflocculation and trickling filters with fixed spray jets	*Bioflocculation and filters with rectangular traveling distributors*	*Filters with fixed sprays*	*Filters with rectangular traveling distributors*
Flow, M.g.d.	7.5	12.0	15.0	4.0
Aeration, hrs.	1	1	..	..
M.g./acre/day	1.136	1.250	0.650	0.635
Capital cost per person[1] $	3.06	2.68	3.67	4.23
Operations/person/year[1] $	0.32	0.275	0.26	0.29
Cost per m.g. treated[1] $	27.55	23.50	22.80	29.20
Effluent, oxygen con., p.p.m.	19.2	13.6	23.5	18.1

[1] Exchange figured at $5.00 per pound.